

## Company Presentation

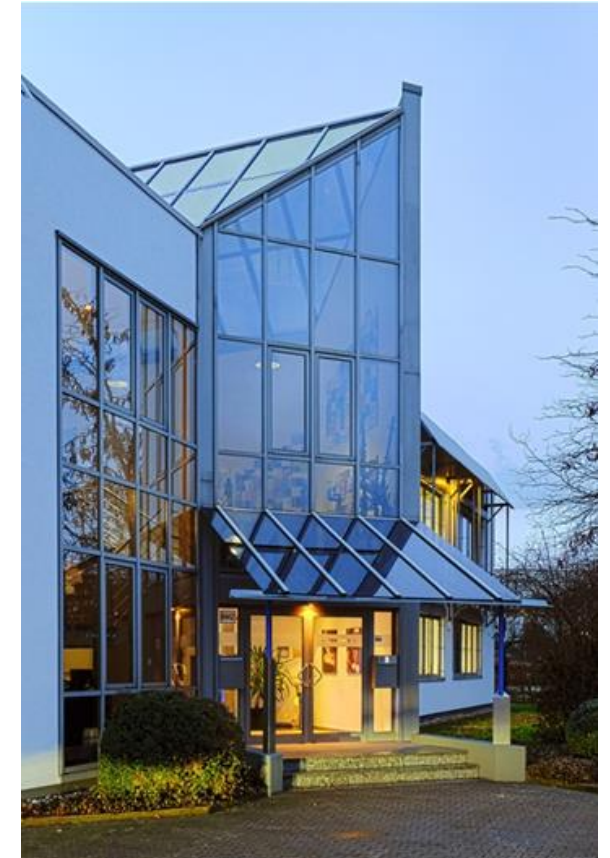
# OUTLINE

- [Presentation of Precitec](#)
- Chromatic Confocal Sensors
  - distance measurement
  - thickness measurement
  - Multipoint/Line Sensors
  - Calibration
- Spectral-interferometric Sensors
  - thickness measurement

# PRESENTATION OF PRECITEC

PRECITEC IS A FAMILY OWNED, INTERNATIONAL OPERATING COMPANY

- Headquarters                      Gaggenau and Neu-Isenburg, Germany
- Employee                            450 world wide
- Turnover 2015                    EUR 82 million
- Development                      10% - 20% p.a.



Headquarter Gaggenau

# PRESENTATION OF PRECITEC

## BUSINESS FIELDS

### Precitec GmbH & Co. KG in Gaggenau

#### Laser Cutting



- Solid state / CO<sub>2</sub>
- Fled bed cutting
- 3D-cutting
- Fine cutting
- Tube cutting
- Bevel cutting
- High-Speed-cutting

#### Laser Welding



- Solid state / CO<sub>2</sub>
- Hybrid-welding
- Remote-welding
- Laser cladding
- Monitoring and control systems for Pre-, In-, Post-process

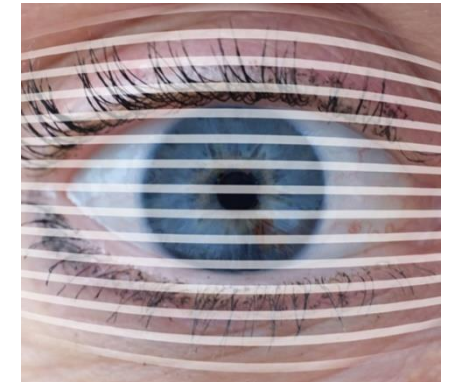
### Precitec Optronik GmbH in Neu-Isenburg

#### Optical Sensors



- Point Sensors
- Line Sensors
- Distance
- Thickness
- Topography

#### Medical



- Control for corneal and refractive surgery
- Eye tracking systems

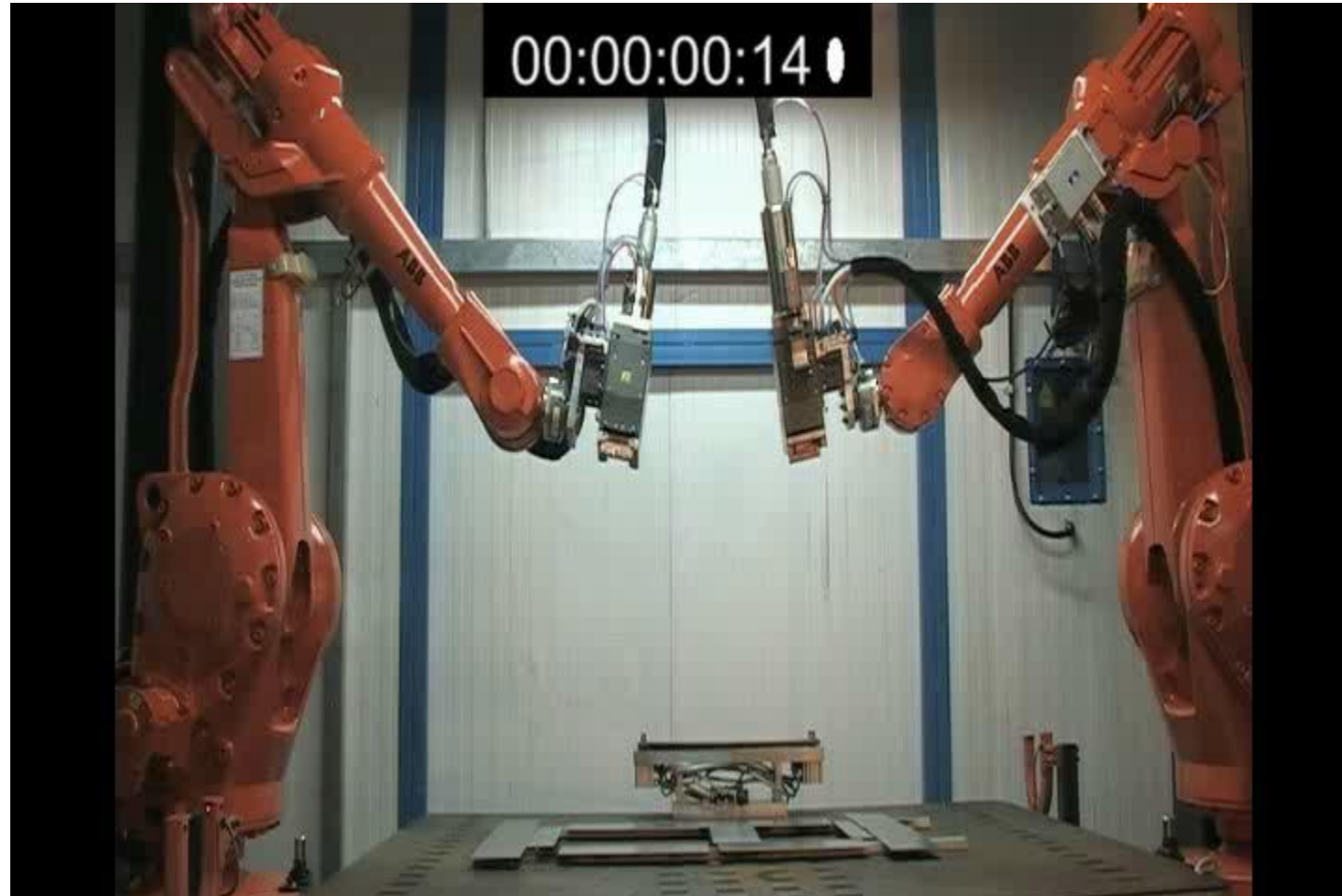
# PRESENTATION OF PRECITEC

BUSINESS FIELD – LASER CUTTING



# PRESENTATION OF PRECITEC

BUSINESS FIELD – LASER WELDING



# PRESENTATION OF PRECITEC

## WORLDWIDE PRESENCE

22 representatives and sales offices.



# PRESENTATION OF PRECITEC

## PRECITEC OPTRONIK GMBH IN NEU-ISENBURG

- Location Neu-Isenburg near Frankfurt
- Employee 85 in Neu-Isenburg
- Turnover 2015 EUR 15 million
- Development 10% - 20% p.a.
- Industries
  - Consumer electronics
  - Glass industry
  - Semiconductor industry
  - Medical industry
  - Plastics industry
  - Coordinate measuring machines



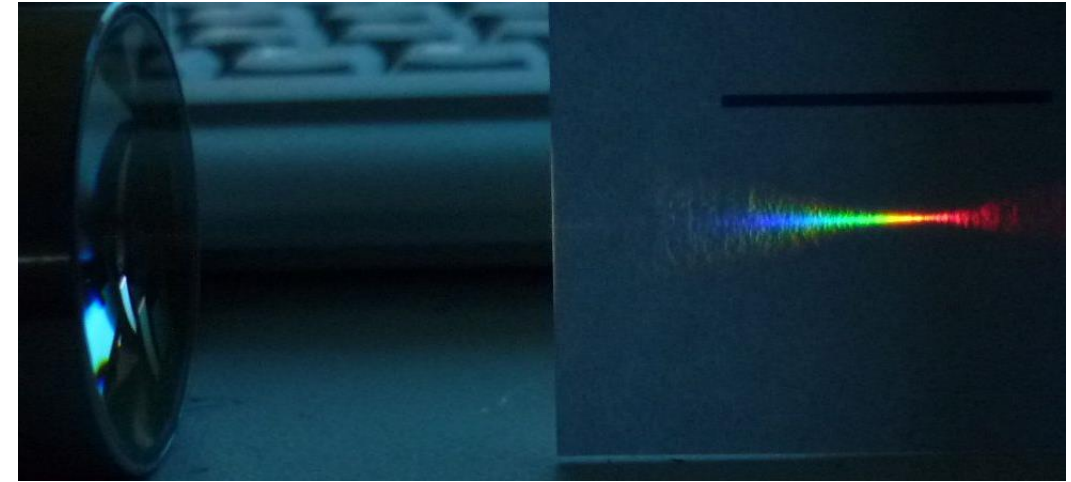
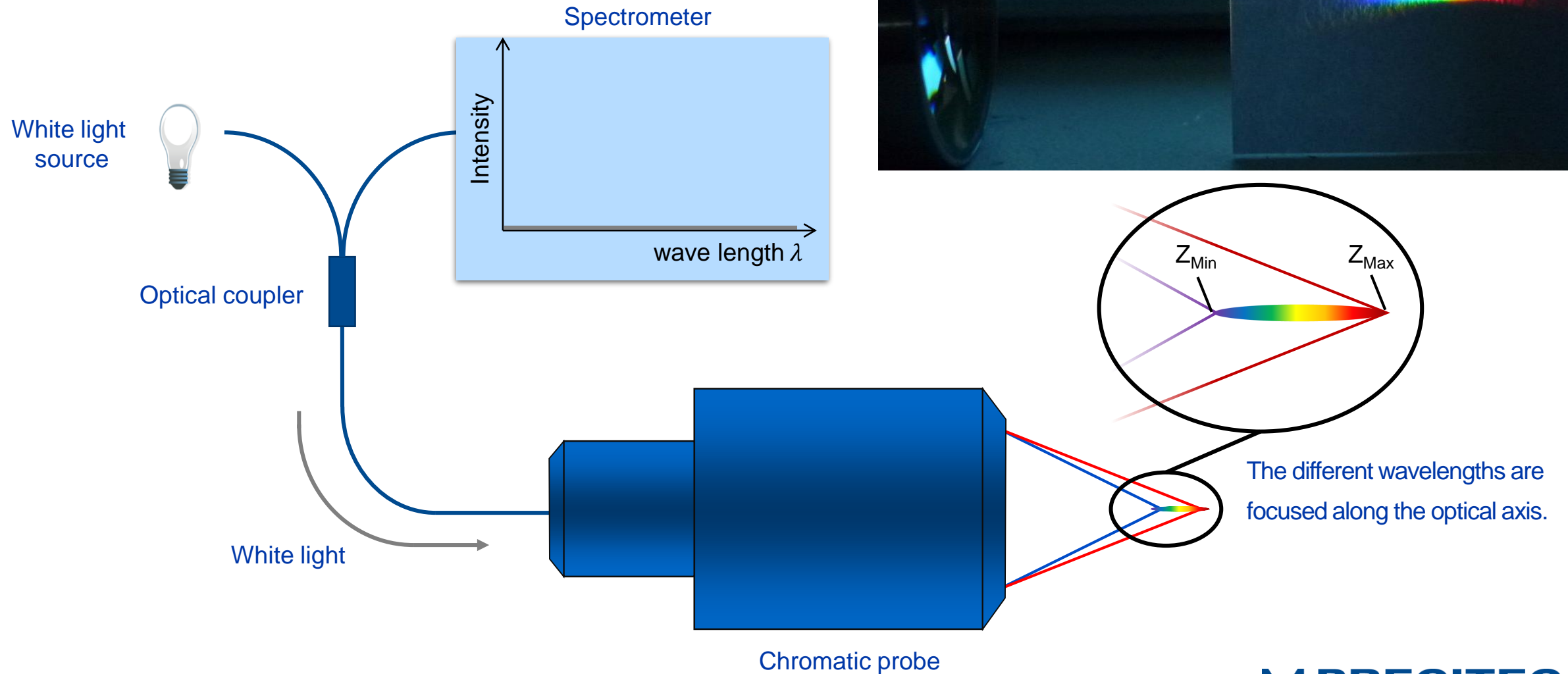


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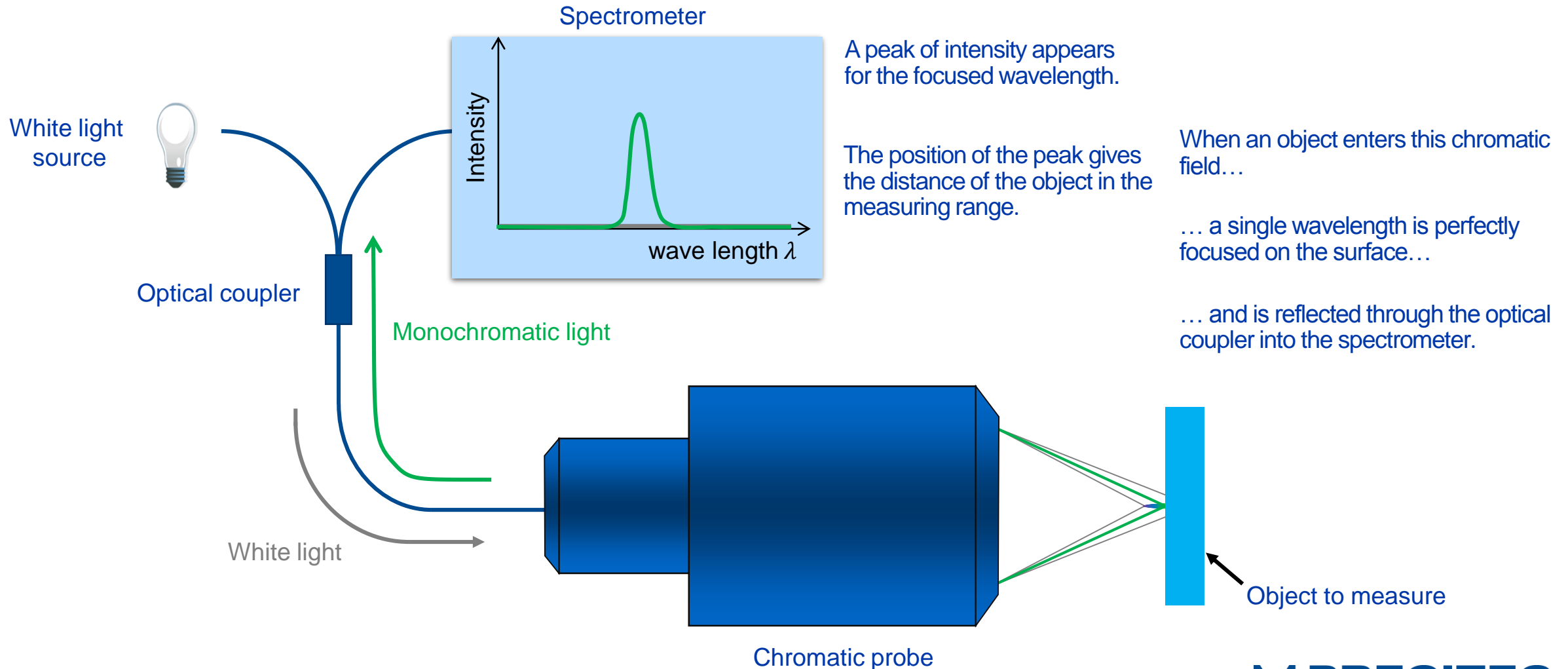
# TECHNOLOGY AND ADVANTAGES

## CONFOCAL CHROMATIC SENSOR – HOW IS IT WORKING?



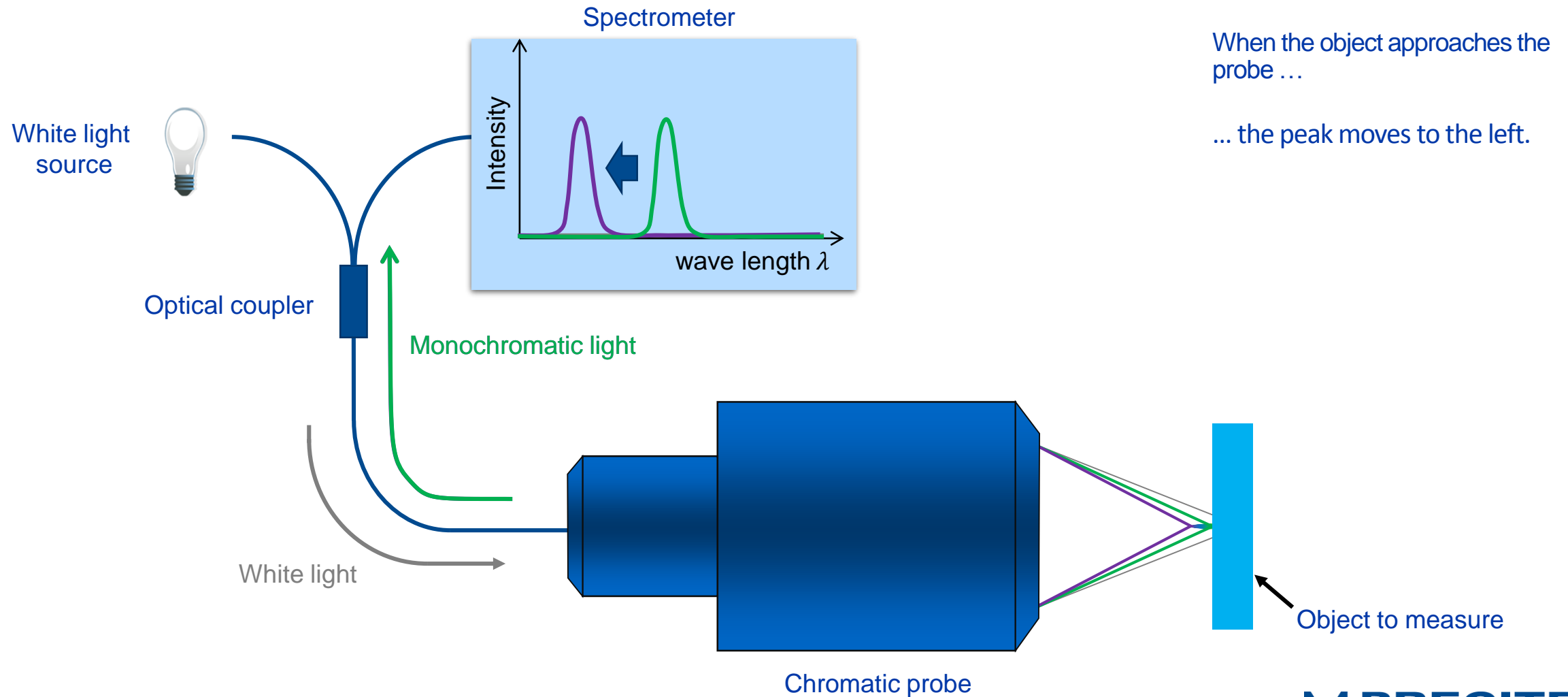
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## CONFOCAL CHROMATIC SENSOR – HOW IS IT WORKING?



# TECHNOLOGY AND ADVANTAGES

## CONFOCAL CHROMATIC SENSOR – HOW IS IT WORKING?

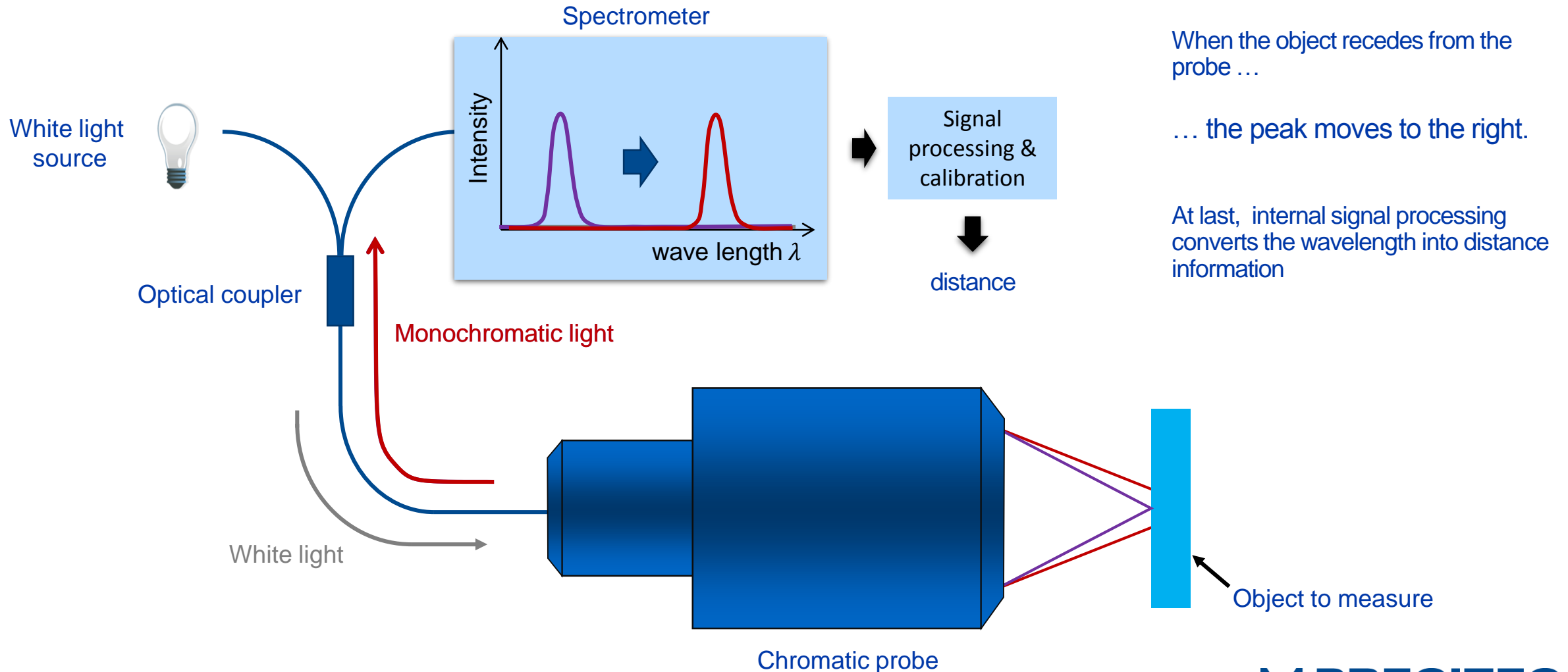


When the object approaches the probe ...

... the peak moves to the left.

# TECHNOLOGY AND ADVANTAGES

## CONFOCAL CHROMATIC SENSOR – HOW IS IT WORKING?



# TECHNOLOGY AND ADVANTAGES

CONFOCAL CHROMATIC TECHNOLOGY OFFERS MANY ADVANTAGES:

- Measurement is possible on any kind of materials
  - Opaque or transparent
  - Absorbing or colored
  - Diffusive or reflective (mirror-like)
  - Rough or polished
- Coaxial measurement avoids shadowing effects
- Very high slope acceptance, high Numerical Aperture
  - Up to 45° on reflective surfaces
  - > 80° on diffusive surfaces
- No laser inside → No speckle effect

# TECHNOLOGY AND ADVANTAGES

CONFOCAL CHROMATIC TECHNOLOGY OFFERS MANY ADVANTAGES:

- Very high Z axis resolution and accuracy (down to a few nanometers)
  - Every measuring period delivers a measuring value
- Small and constant spot size (a few microns) → high lateral resolution
- The optical probe is totally passive, without any moving part, nor embedded electronics (heat source)
  - High thermal stability
  - No possible misalignment
  - Long term reliability and reproducibility
- Parallel measuring of many points possible

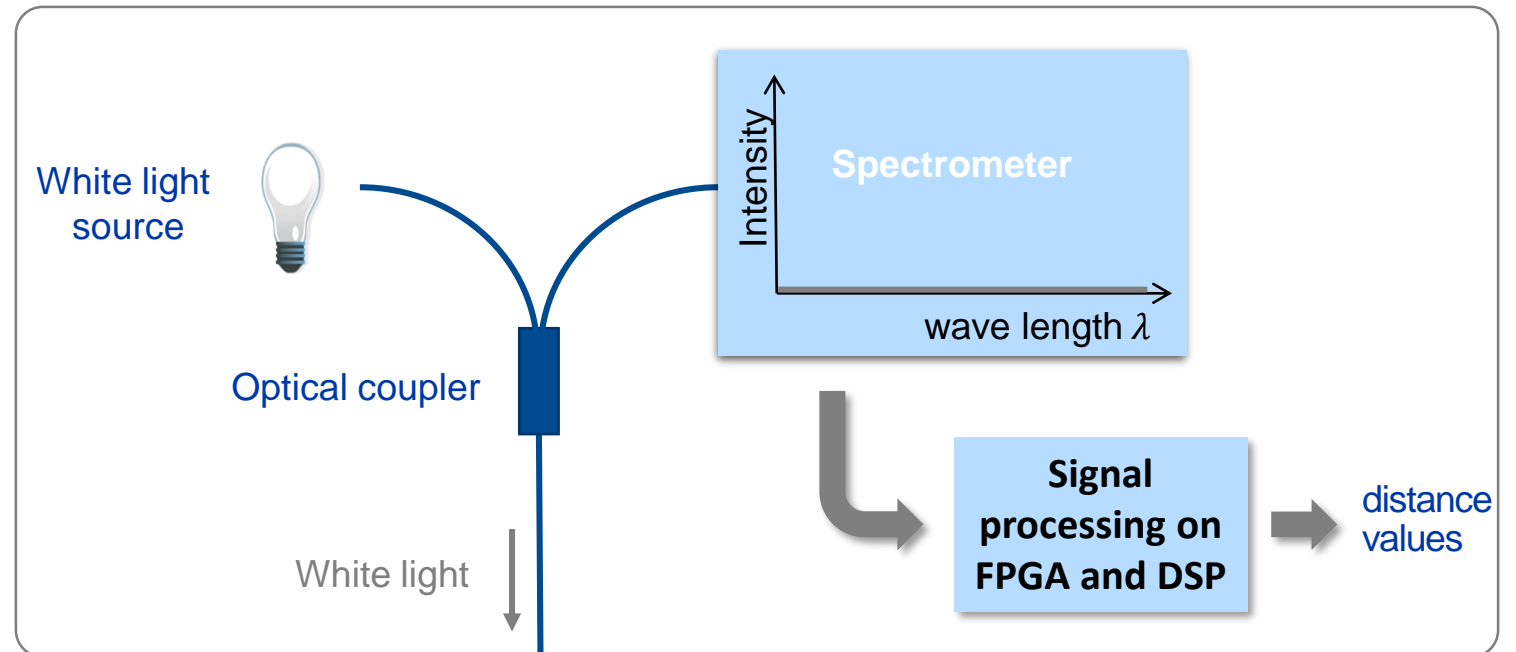
# CHROMATIC CONFOCAL SENSORS

## CONTROLLER UNITS OF CHRocODILE 2 SERIES:

- Measurements per second up to 66,000
- Two functions (measuring mode):
  - Distance measurement
  - Thickness measurement
- Synchronization I/O
- Ethernet or RS422
- Analogue outputs
- Up to 5 encoders inputs



Schematic structure of the CHRocodile 2 S





# CHROMATIC CONFOCAL SENSORS

## OPTICAL PROBES

- Measuring ranges from 100  $\mu\text{m}$  up to 25 mm
- Resolution down to 3 nm
- Angle acceptance up to :
  - 45° on specular surfaces
  - > 80° on diffusive surfaces
- Angled probes (90°) available
- All probes are available in a vacuum version.

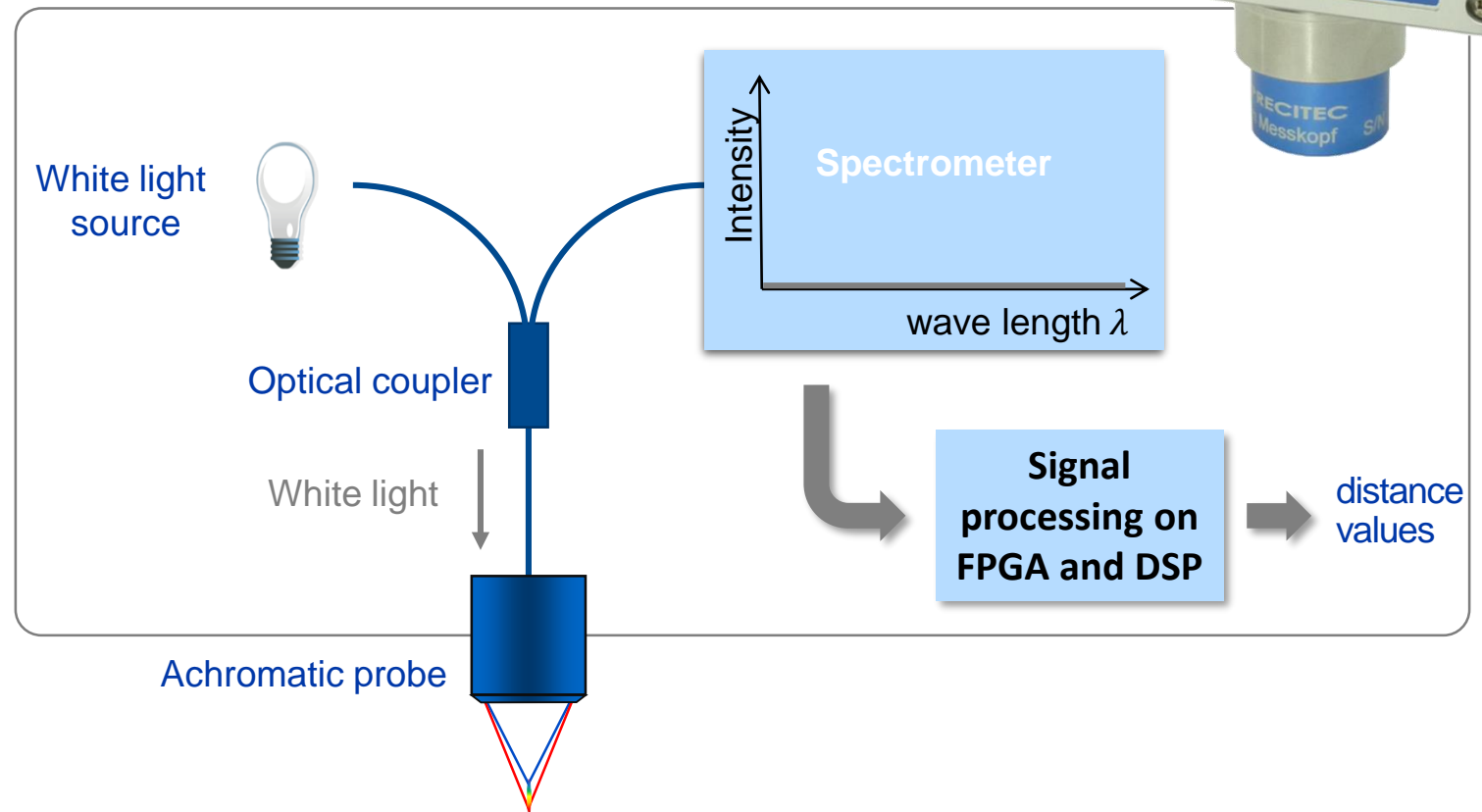


# CHROMATIC CONFOCAL SENSORS

## CONTROLLER UNITS AND PROBE IN ONE – CHRcodILE C

- Measurements per second up to 4,000
- Distance or thickness measurement
- Ethernet or RS422
- Analogue outputs
- Up to 5 encoders inputs
- Interchangeable chromatic probes:
  - 200  $\mu\text{m}$  measuring range
  - 1 mm measuring range
  - 4 mm measuring range
  - 10 mm measuring range
- Alternative for laser triangulators

Schematic structure of the CHRcodile C



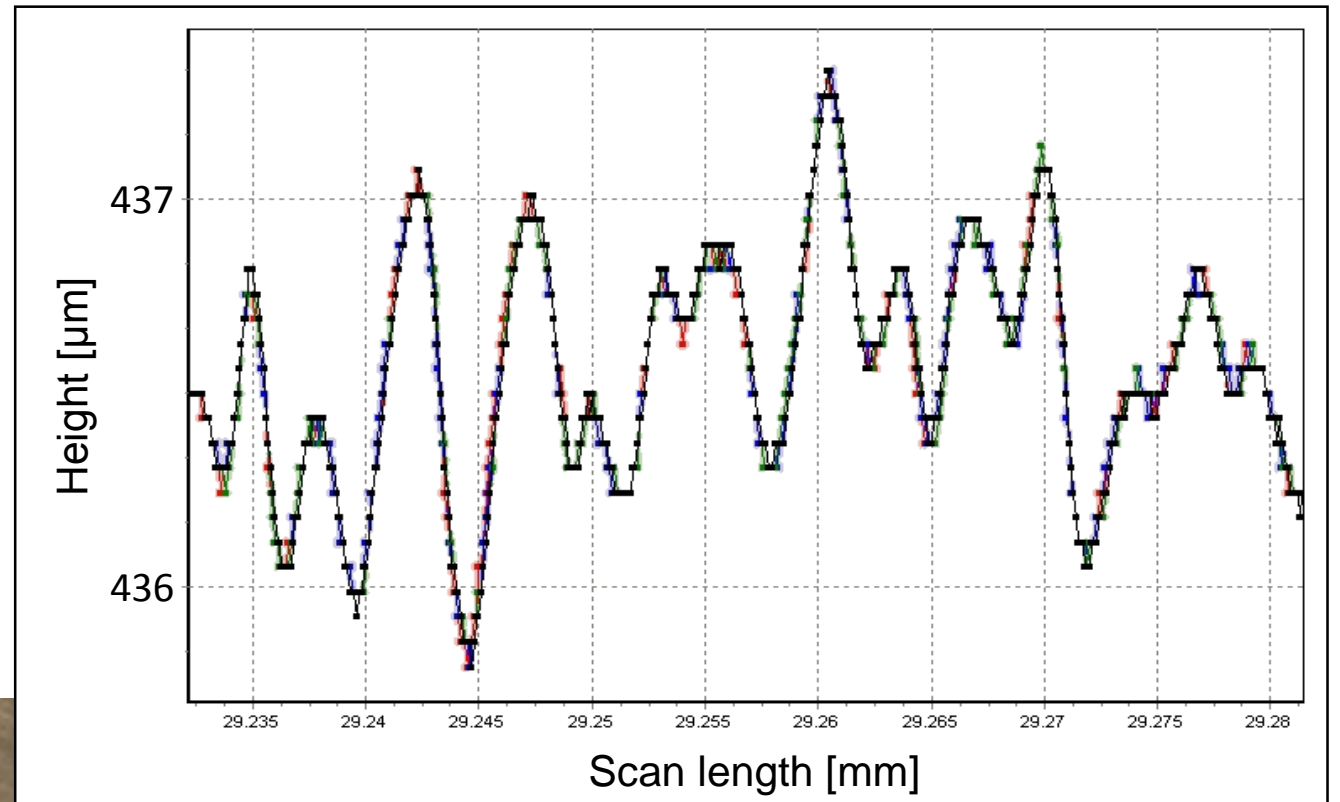
# APPLICATION EXAMPLES

## ROUGHNESS MEASUREMENT

- Optical Sensor: CHRocodile 2HS
- Optical Probe: 1 mm measuring range
- Scan area: 12 mm x 18 mm
- Z range: 2  $\mu\text{m}$
- X resolution: 0.1  $\mu\text{m}$
- Measurements / second: 4,000

## Repeatability

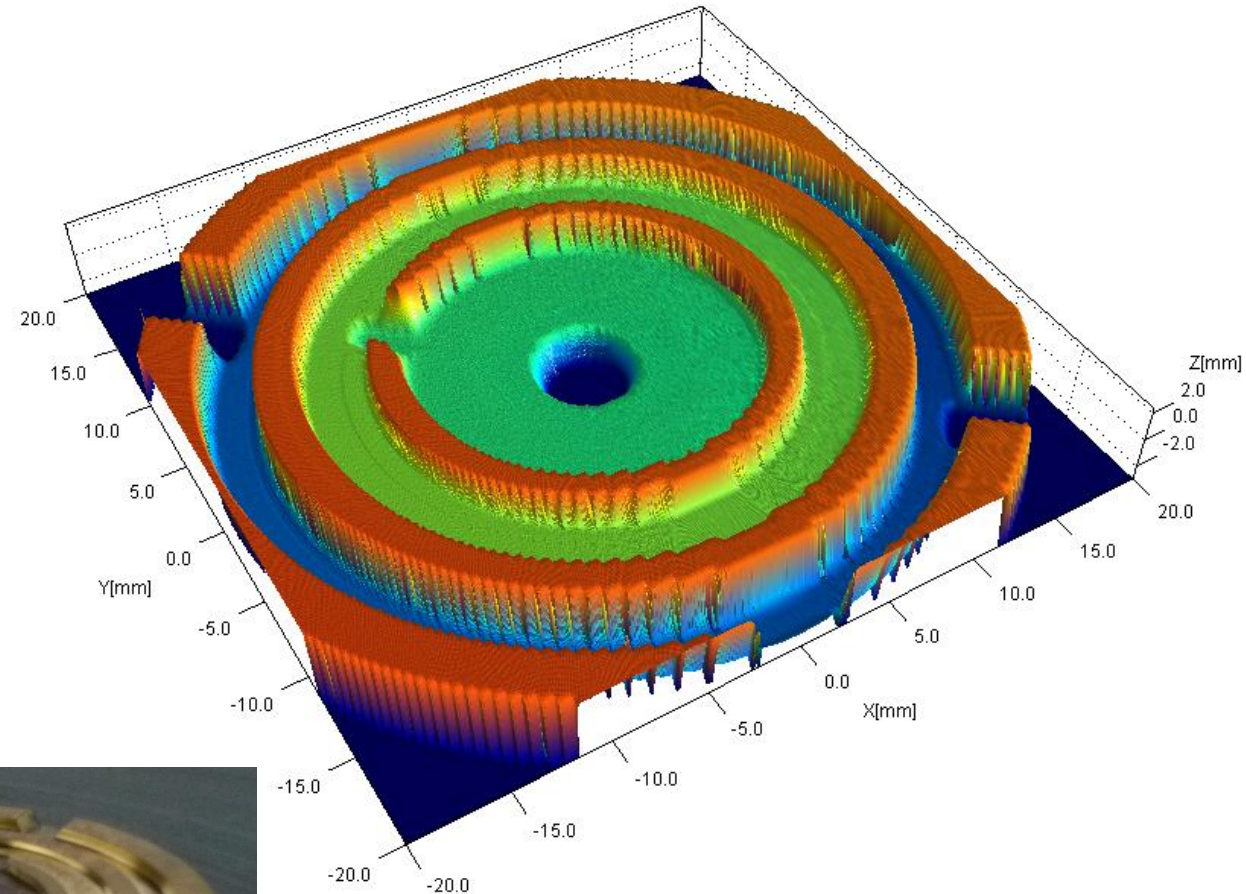
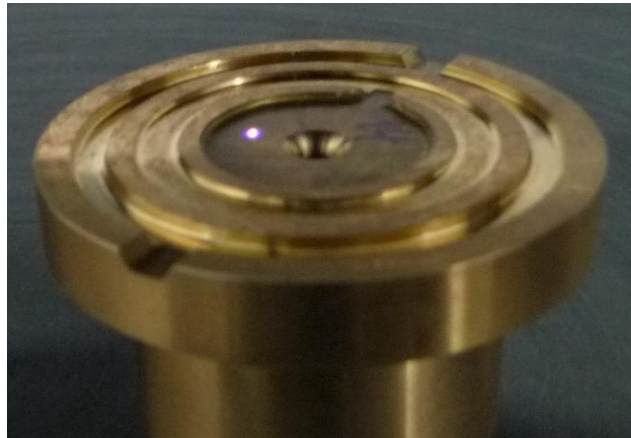
4 profiles measured on the roughness standard



# APPLICATION EXAMPLES

## EVENNESS OF HYDRAULIC SLIDE SHOES

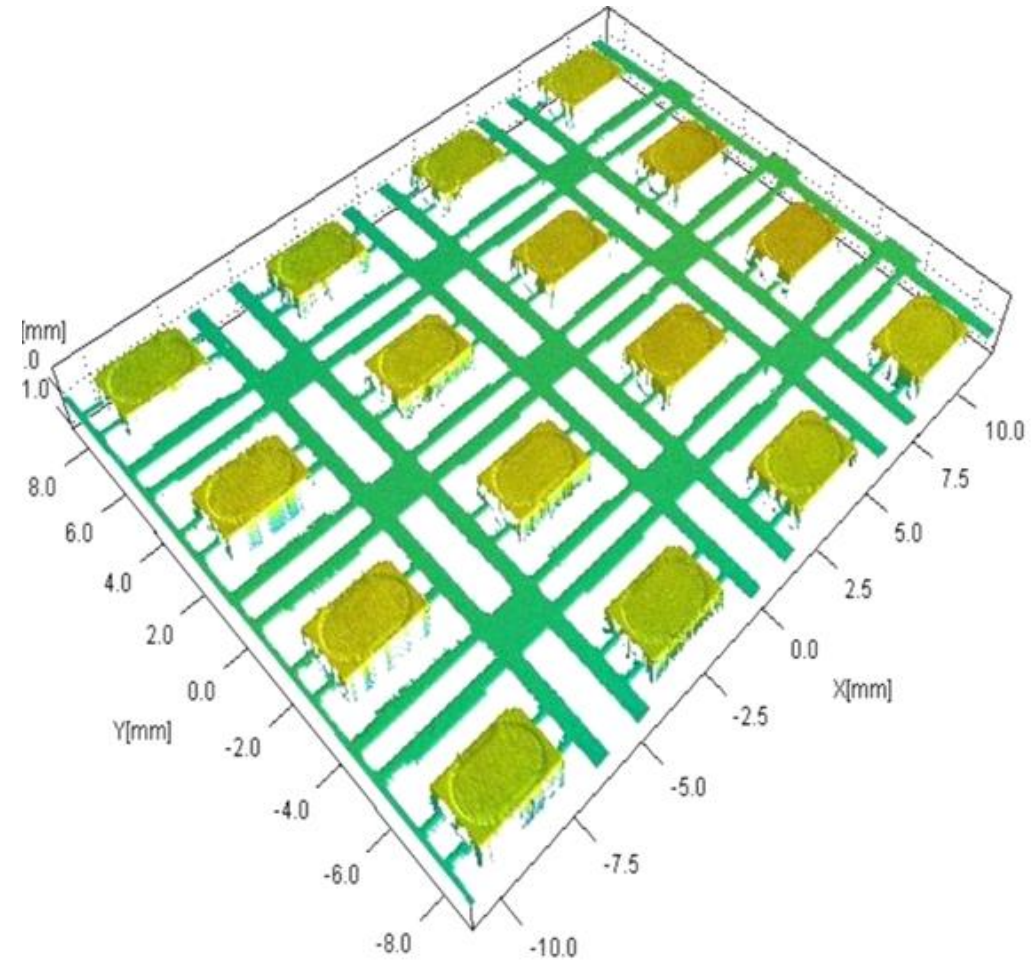
- Optical Sensor: CHRocodile 2S
- Optical Probe: 3 mm measuring range
- Scan area: 12 mm x 18 mm
- Z range: 2 mm
- X,Y resolution: 20  $\mu\text{m}$  x 20  $\mu\text{m}$
- Measurements / second: 20,000



# APPLICATION EXAMPLES

## LED CHIPS PACKAGING: BACK LIGHTING OF LCD DISPLAYS

- Optical Sensor: CHRcodile 2S
- Optical Probe: 3 mm measuring range
- Scan area: 12 mm x 18 mm
- Z range: 1 mm
- X,Y resolution: 20  $\mu\text{m}$  x 20  $\mu\text{m}$
- Measurements / second: 20,000



# INTEGRATION EXAMPLES

## COORDINATE MEASURING MACHINE & AUTOMATED OPTICAL INSPECTION



Carl Zeiss Messtechnik GmbH



Werth Messtechnik GmbH



Hexagon Metrologie GmbH

# INTEGRATION EXAMPLES

## 3D SURFACE SCANNER



Cyber technologies GmbH



FRT GmbH

# INTEGRATION EXAMPLES

AUTOMATED CAR BODY INSPECTION BY AKCULATE



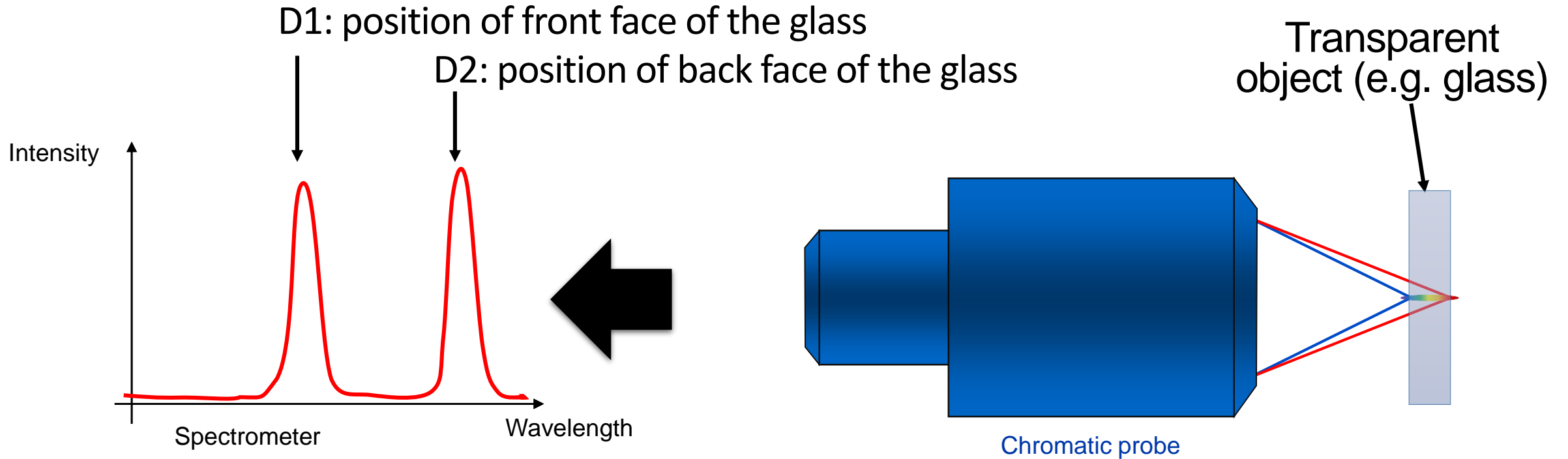


# OUTLINE

- Presentation of Precitec Optronik
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# TECHNOLOGY AND ADVANTAGES

## CONFOCAL CHROMATIC SENSOR – HOW IS IT WORKING?



Two wavelengths are focused: one on the front face, one on the back face.

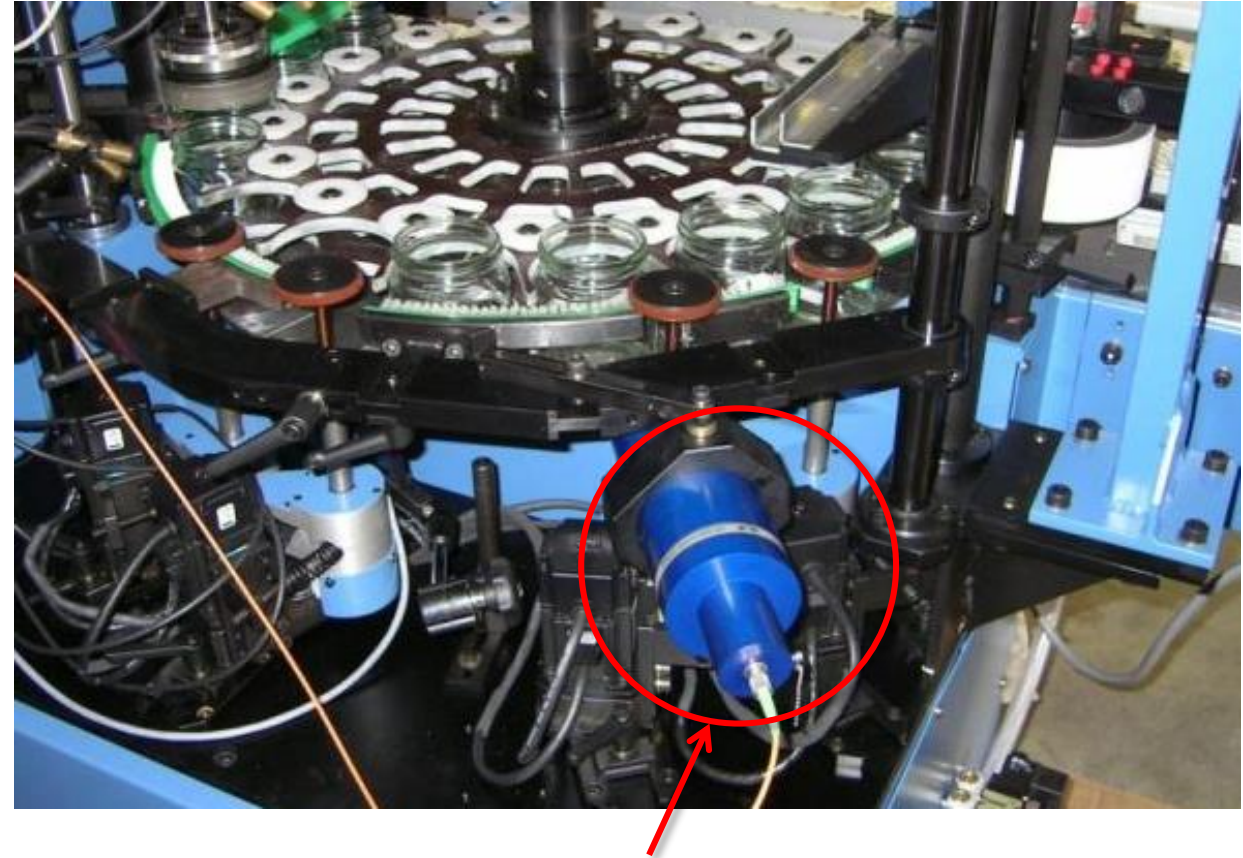
Thickness =  $n (D2 - D1)$  where  $n$  is the refractive index of the material

# INTEGRATION EXAMPLES

## AUTOMATED CONTAINER GLASS INSPECTION



Heye International GmbH



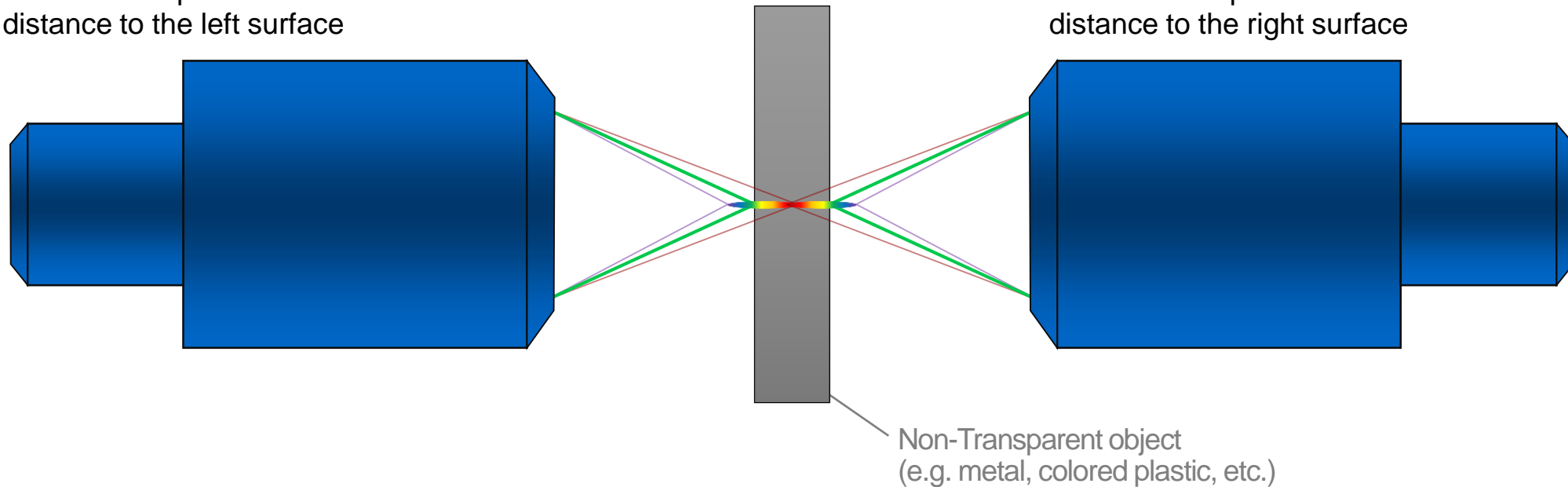
Optical wall thickness measurement

# TECHNOLOGY AND ADVANTAGES

## CHROMATIC CONFOCAL SENSOR – THICKNESS MEASUREMENT OF NON-TRANSPARENT SAMPLES

1<sup>st</sup> chromatic probe measures the distance to the left surface

2<sup>nd</sup> chromatic probe measures the distance to the right surface

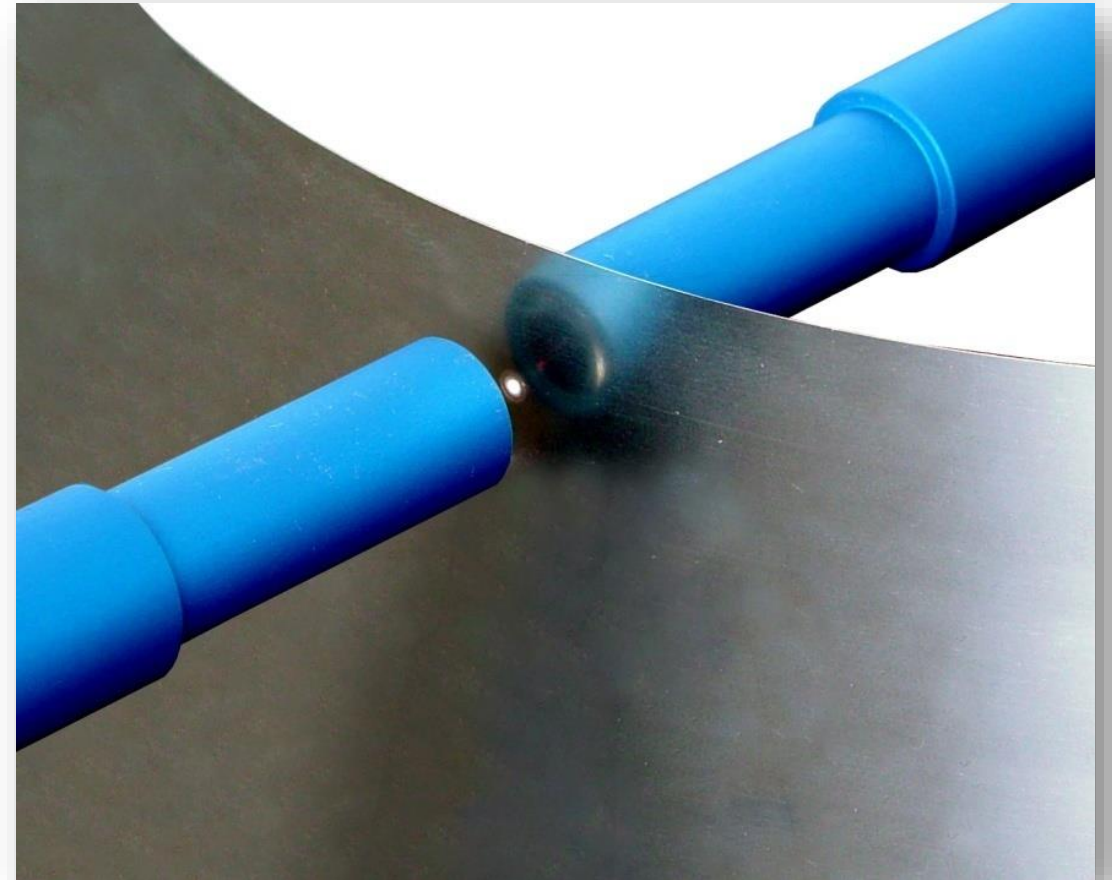


By two distance measurements from both sides of the non transparent sample, the thickness can be measured

# TECHNOLOGY AND ADVANTAGES

## CHROMATIC CONFOCAL SENSOR – THICKNESS MEASUREMENT OF NON-TRANSPARENT SAMPLES

- Measurement of
  - Metal bands
  - Paper
  - Plastic
  - Ceramic
  - Very rough silicon or glass
- Reliable measurement requires
  - Solid frame for the optical probes
  - Thickness reference gauge
  - 2 CHRcodile sensors, which are running synchronized



# INTEGRATION EXAMPLES

THICKNESS MEASUREMENT OF NON-TRANSPARENT FOILS BY IC AUTOMATION

ic automation

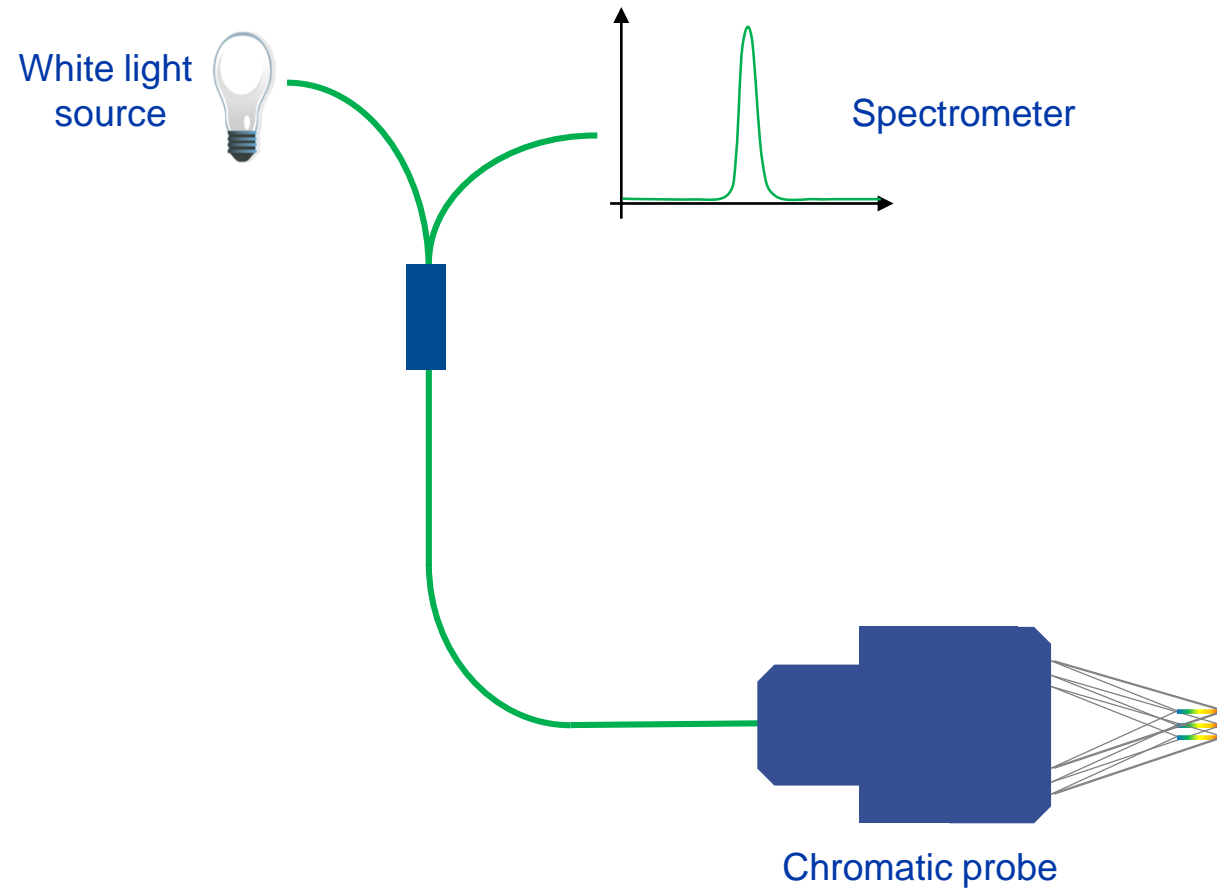
The conceivable is feasible.

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# TECHNOLOGY AND ADVANTAGES

## CONFOCAL CHROMATIC LINE SENSOR – HOW IS IT WORKING?

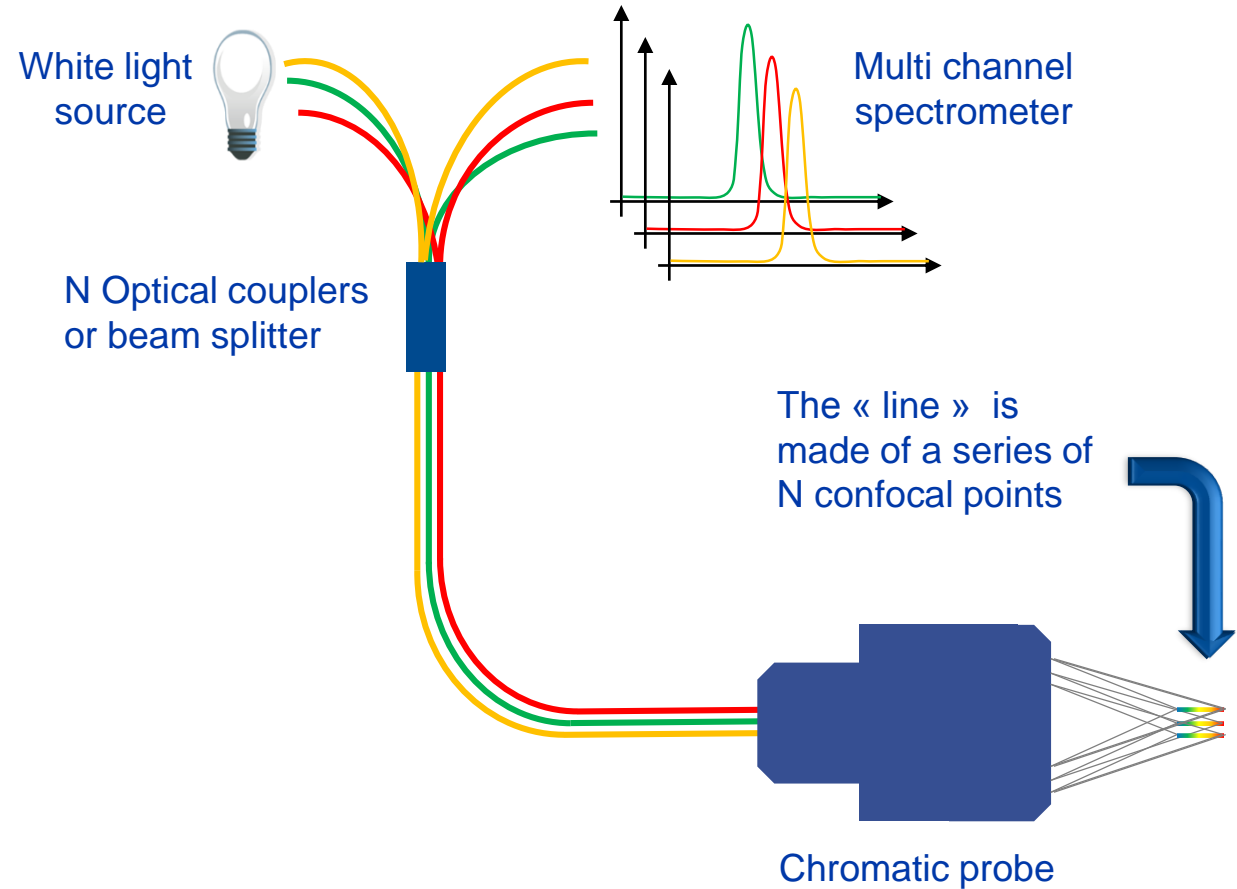


From a point sensor...



# TECHNOLOGY AND ADVANTAGES

## CONFOCAL CHROMATIC LINE SENSOR – HOW IS IT WORKING?



... to a line sensor.

# CHROMATIC LINE SENSORS

## CHROCODILE CLS

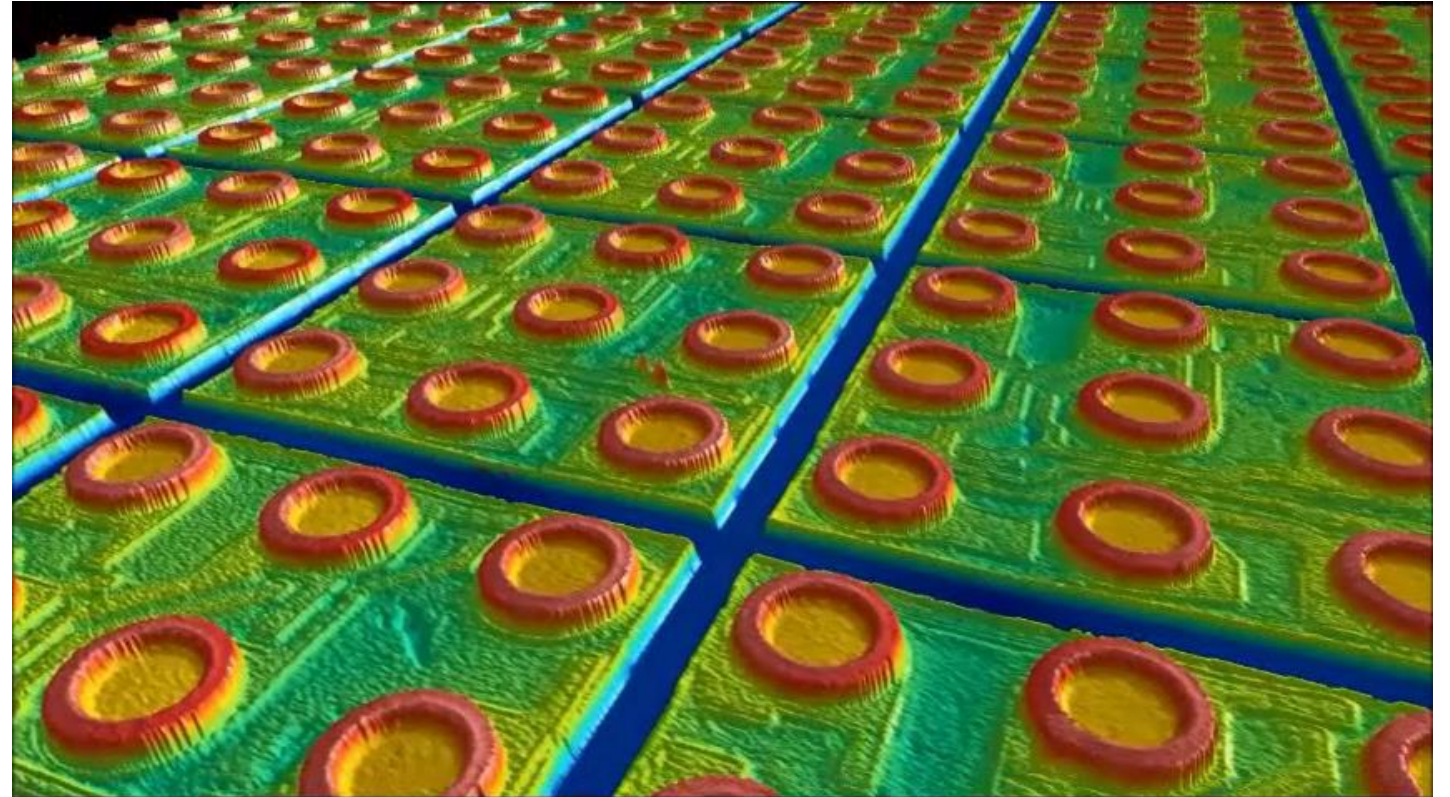
- Measuring speed up to 1,152,000 points per second (6,000 lines/sec)
- 192 points along the line
- « All in one » design
- Interchangeable chromatic probes:
  - 200 µm measuring range
  - 1 mm measuring range
  - 2.3 mm measuring range
  - 4 mm measuring range
- Ethernet interface
- 5 encoders inputs



# APPLICATION EXAMPLES

## CHROCODILE CLS: BUMPED WAFER

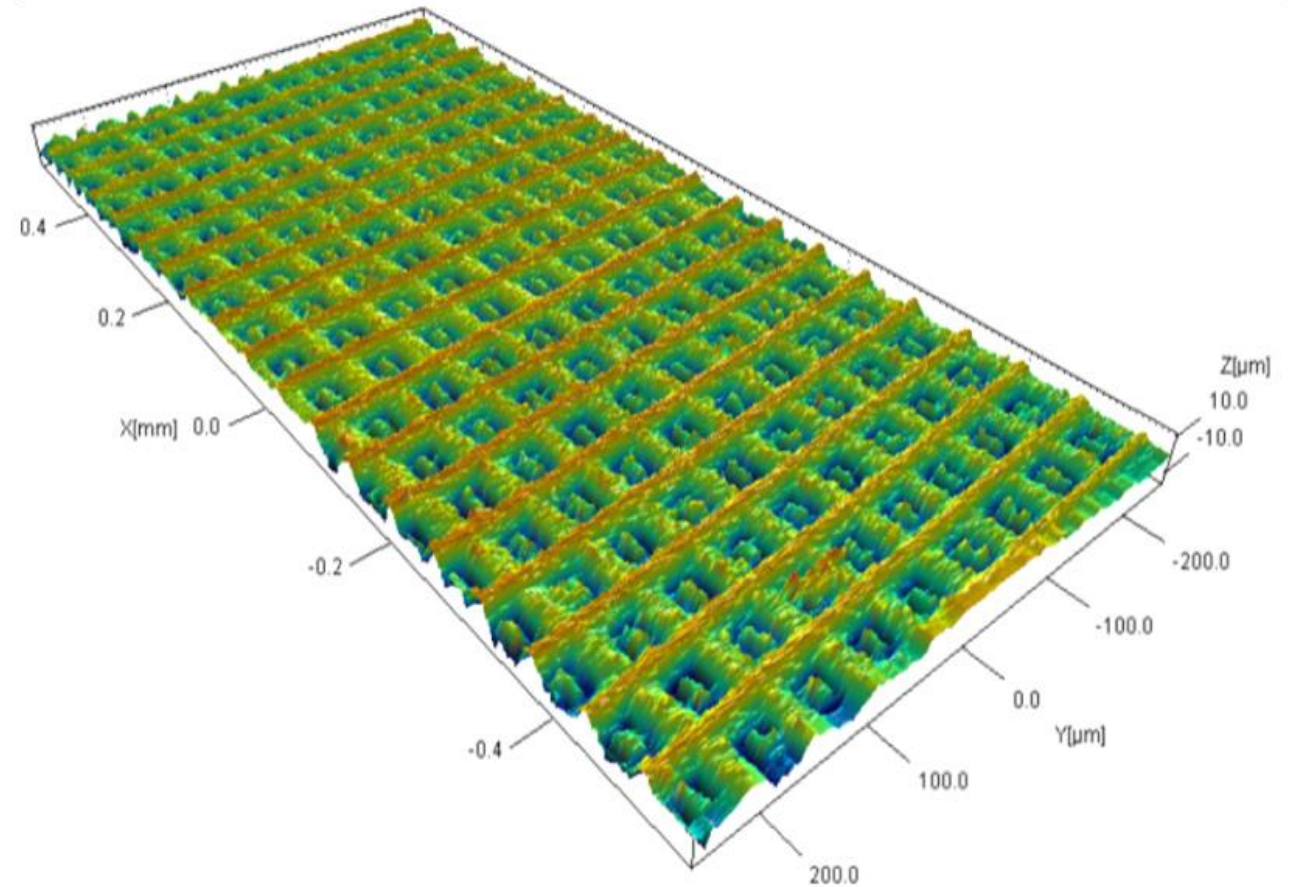
- Sensor: CHRocodile CLS
- Optical Probe: 1 mm
- Scan area: 1.9 mm x 2.2 mm
- Z range: 30  $\mu\text{m}$
- Axial resolution: 20 nm
- Measurements/ second: 6000



# APPLICATION EXAMPLES

## OLED DISPLAY: METALLIC MASK

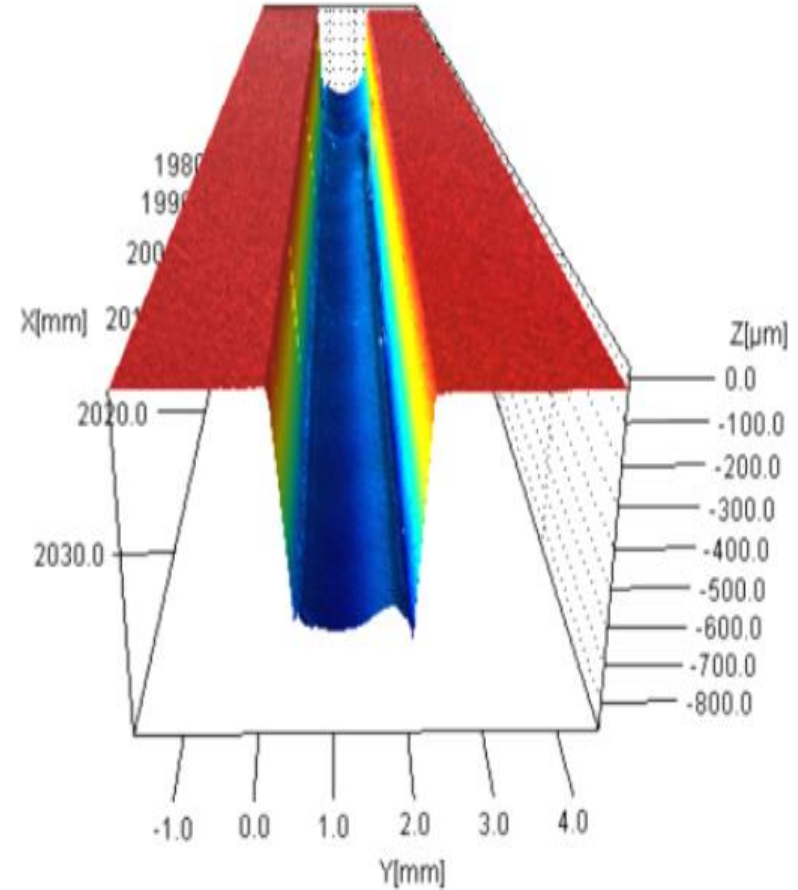
- Sensor: CHRocodile CLS
- Optical Probe: 200  $\mu\text{m}$  measuring range
- Z range: 20  $\mu\text{m}$
- X,Y resolution: 0.5  $\mu\text{m}$  x 5  $\mu\text{m}$
- Scan area: 1 mm x 500  $\mu\text{m}$
- Measuring time: 1 s



# APPLICATION EXAMPLES

## GROOVE ON A TFT GLASS: INSPECTION OF DEPTH

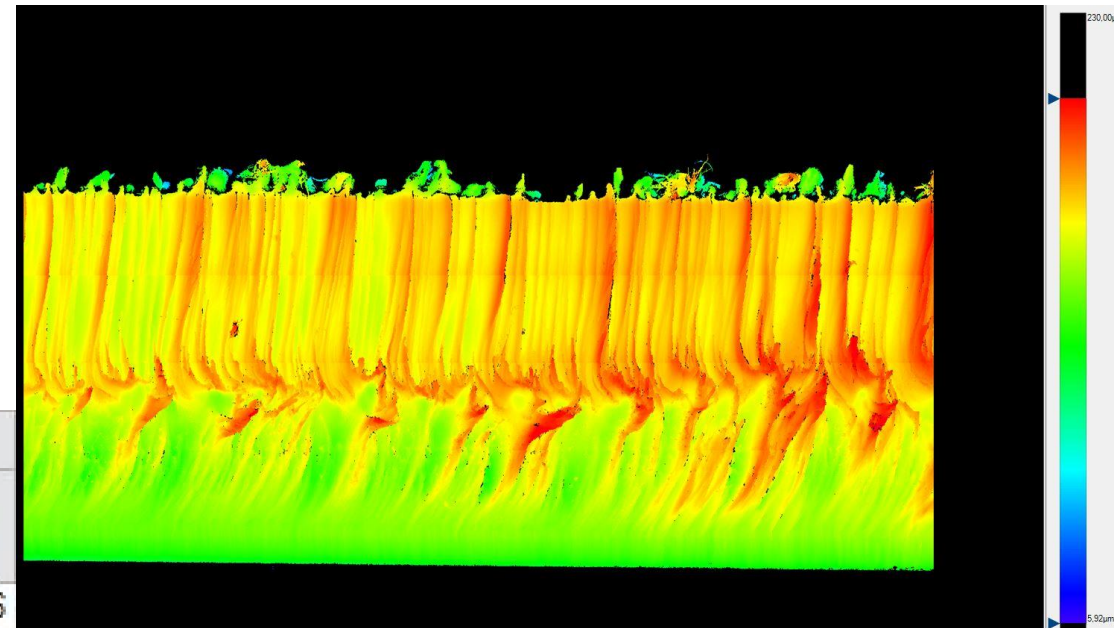
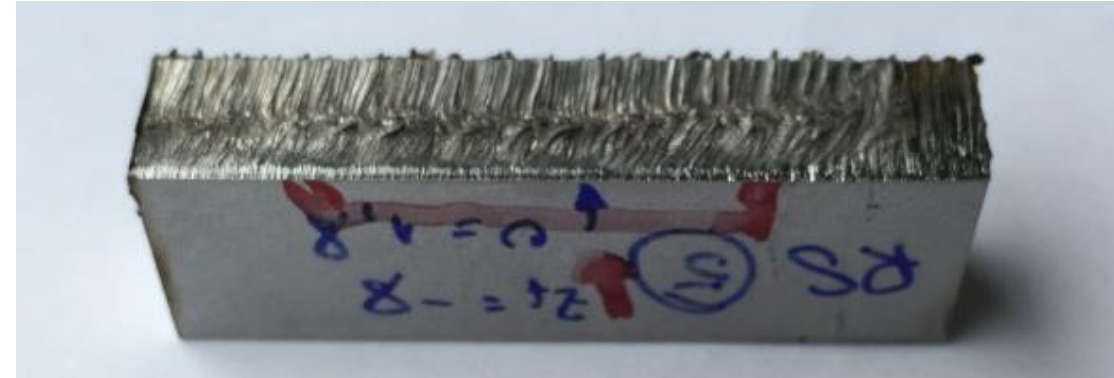
- Optical Sensor: CHRocodile CLS
- Optical Probe: 4 mm measuring range
- Z range: 500  $\mu\text{m}$
- X,Y resolution: 25  $\mu\text{m}$  x 25  $\mu\text{m}$
- Scan area: 5 mm x 60 mm
- Measuring time: 1 s



# APPLICATION EXAMPLES

## LASER CUT METAL: INSPECTION OF GEOMETRY AND ROUGHNESS

- Optical Sensor: CHRocodile CLS
- Optical Probe: 1 mm measuring range
- Z range: 400  $\mu\text{m}$
- X,Y resolution: 10  $\mu\text{m}$  x 10  $\mu\text{m}$
- Scan area: 20 mm x 13.4 mm
- Measuring time: 15 s

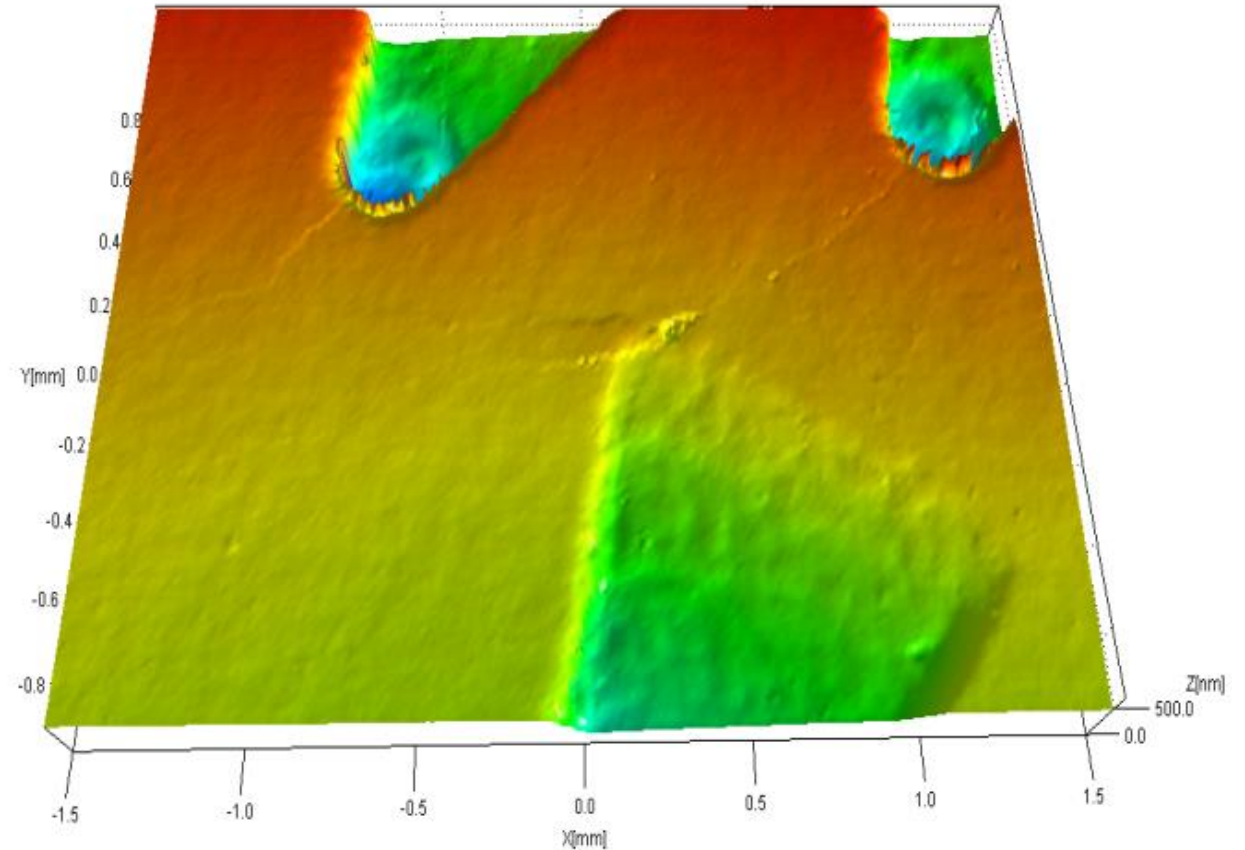


ISO 4287				
Ra [ $\mu\text{m}$ ]	Rq [ $\mu\text{m}$ ]	Rz [ $\mu\text{m}$ ]	Rt [ $\mu\text{m}$ ]	Rsm [ $\mu\text{m}$ ]
34.557	44.477	188.095	271.158	756.656

# APPLICATION EXAMPLES

## TURBINE BLADES: INSPECTION OF FORM, STRUCTURE DEPTH AND CRACKS

- Optical Sensor: CHRocodile CLS
- Optical Probe: 1 mm measuring range
- Z range: 700  $\mu\text{m}$
- X,Y resolution: 10  $\mu\text{m}$  x 10  $\mu\text{m}$
- Scan area: 3 mm x 1.91 mm
- Measuring time: 0.15 s



# OUTLINE

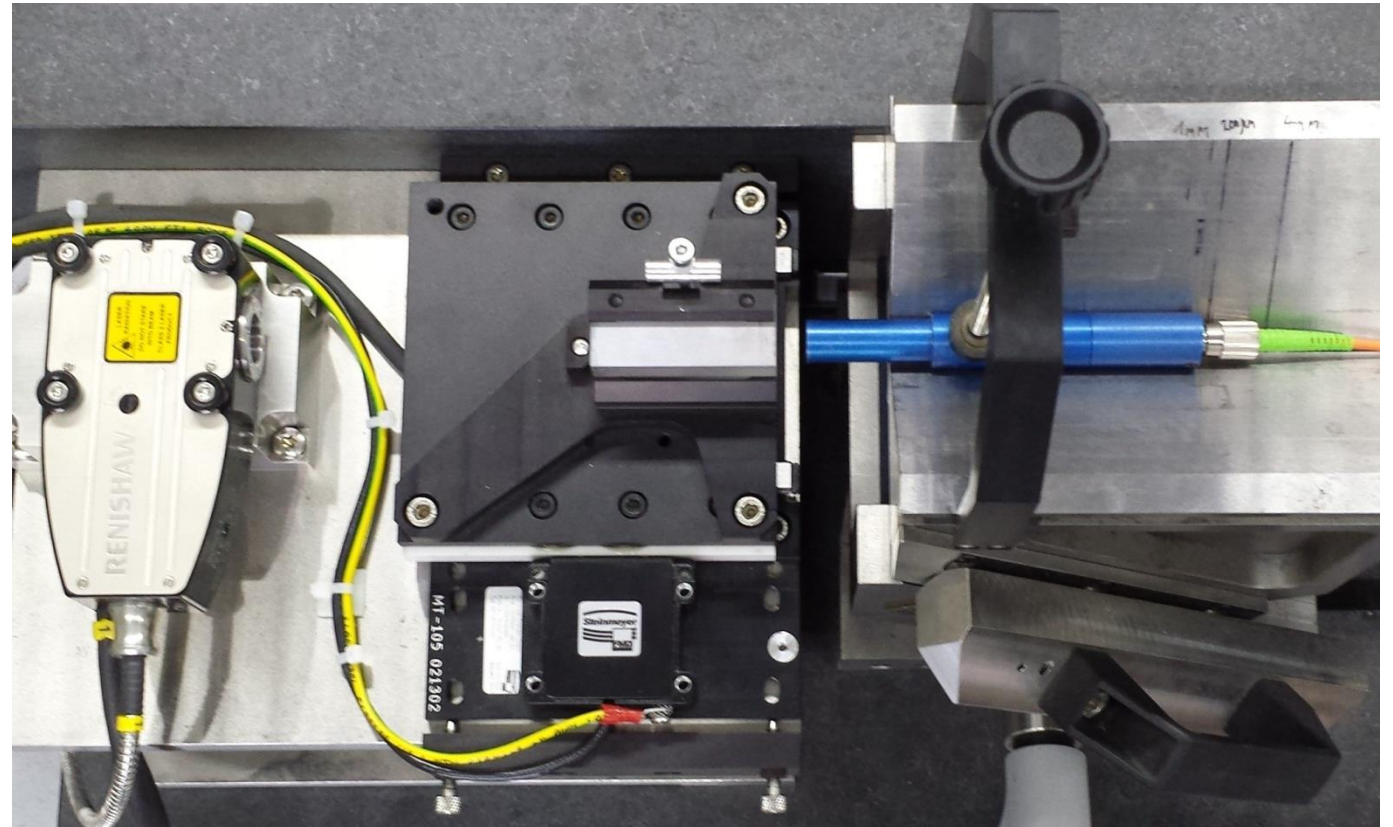
- Presentation of Precitec Optronik
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# SENSOR CALIBRATION

## CALIBRATION PROCESS

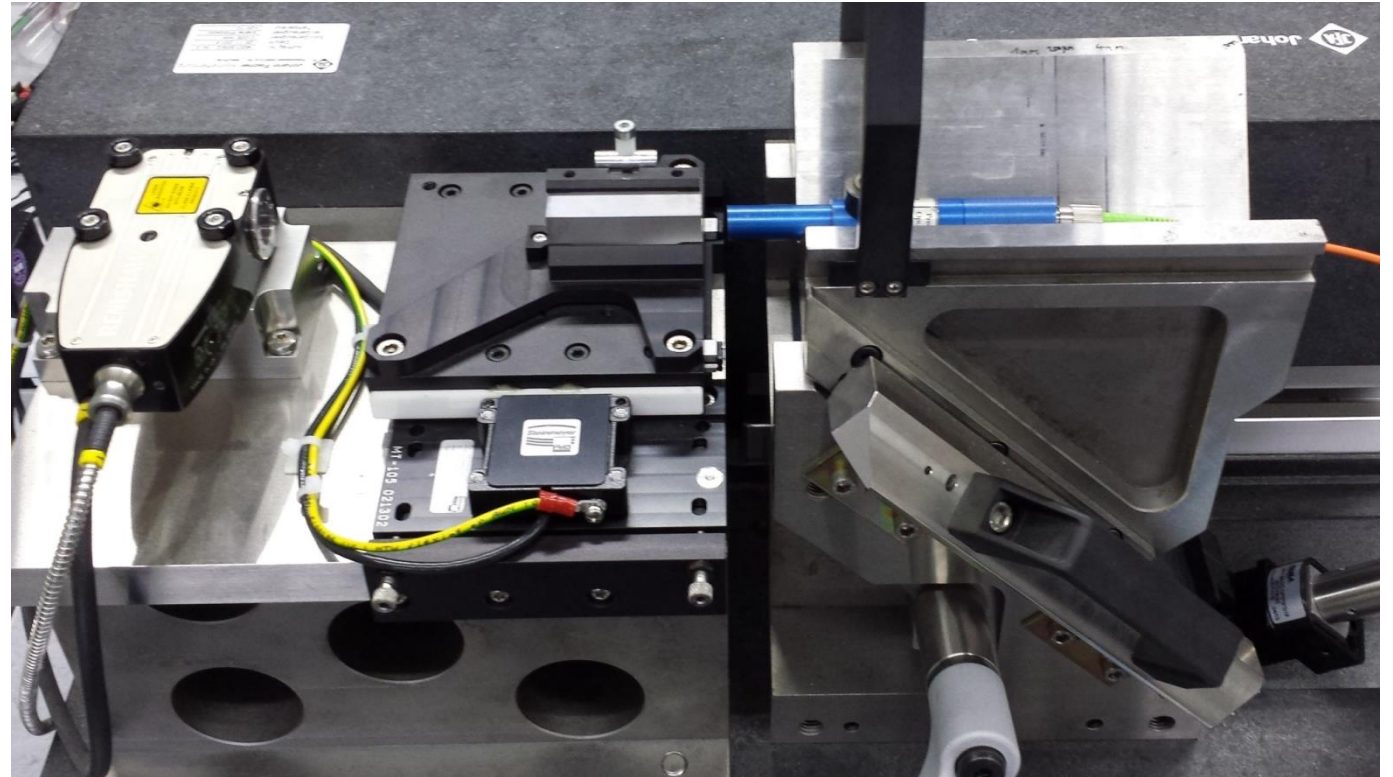
- The sample (a glass block) is moved throughout the measuring range.
- While doing so, the motion is recorded by an interferometer precisely ...
- ... and the peak location in the spectrum is recorded
- Considering those records, a calibration file is created and uploaded to the device



# SENSOR CALIBRATION

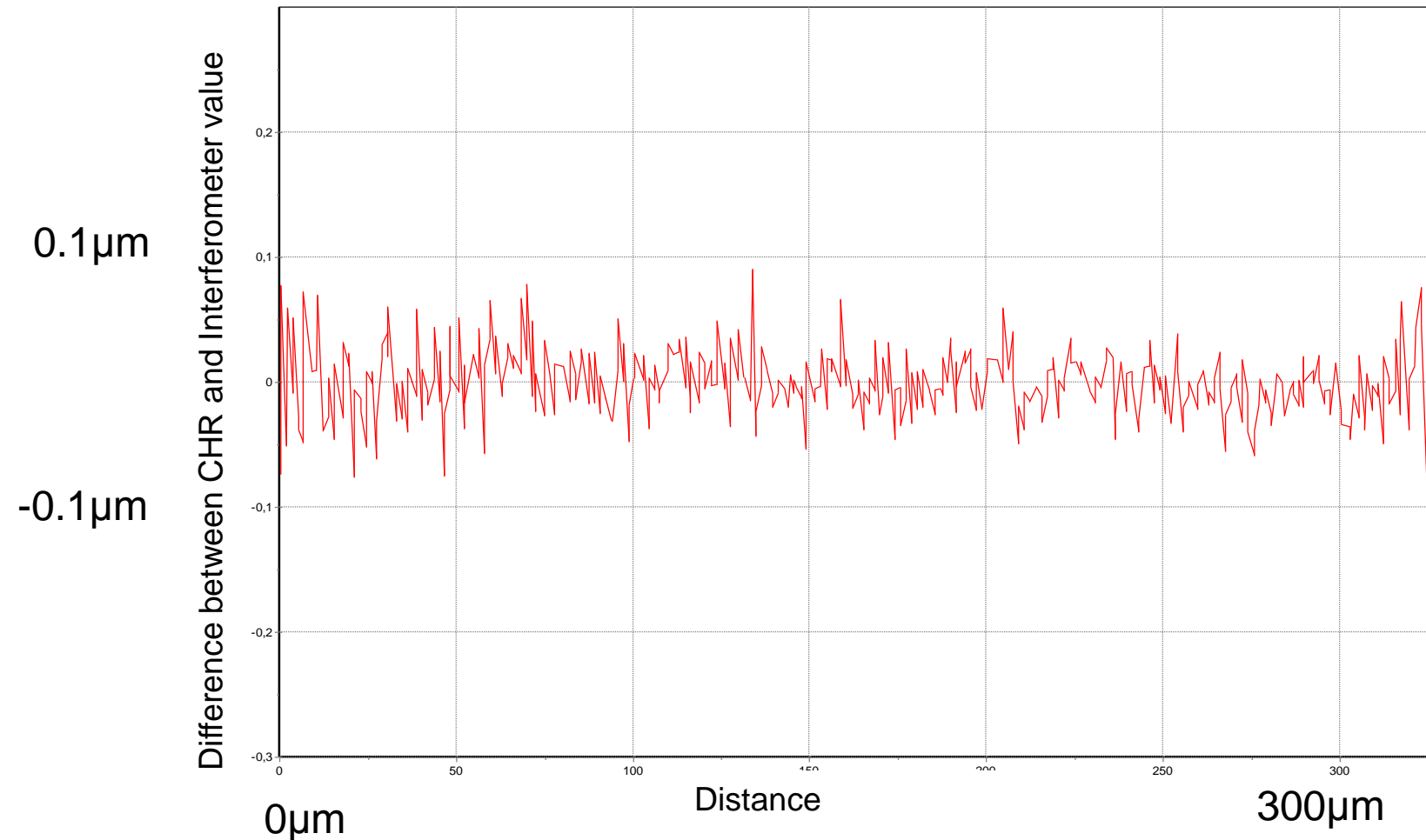
## ADDITIONAL FACTS

- Optical probe and CHRocodile sensor are always calibrated together
- The calibration is necessary to compensate tolerances in the spectrometer and probe optics
  - Since those assembly are stable and have no wear, no recalibration is necessary.
- Anyhow, to check the calibration a thickness or step height gauge can be measured regularly



# SENSOR CALIBRATION

## VERIFICATION OF CALIBRATION BEFORE SHIPMENT



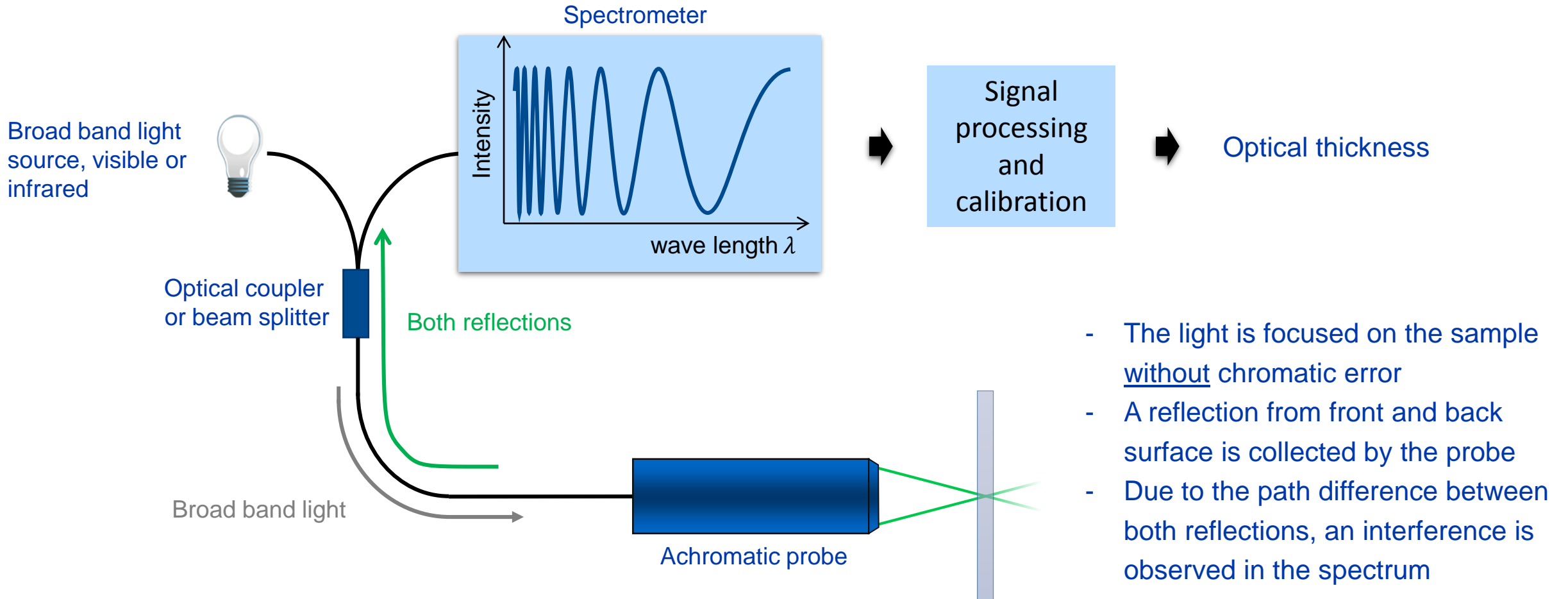
Example for the  
300µm probe

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# TECHNOLOGIES AND ADVANTAGES

## SPECTRAL-INTERFEROMETRIC SENSOR – HOW IS IT WORKING?



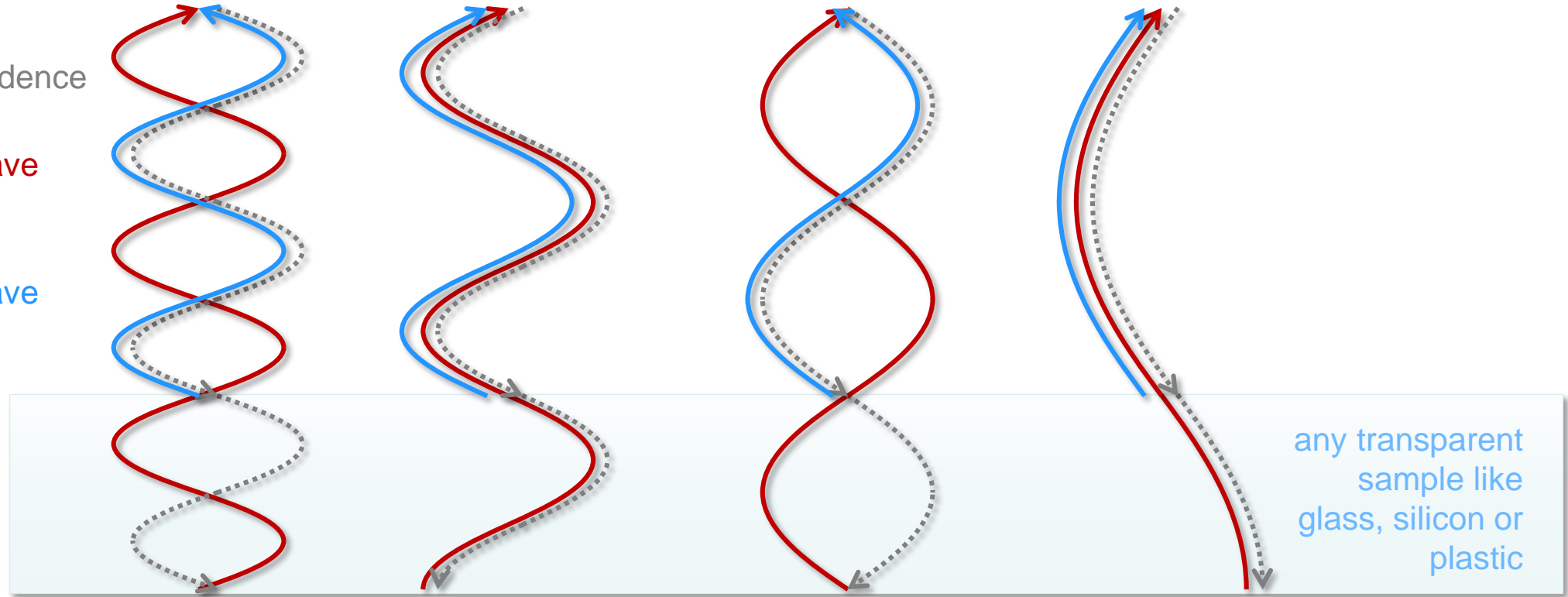
# TECHNOLOGY AND ADVANTAGES

## SPECTRAL-INTERFEROMETRIC SENSOR – HOW IS IT WORKING?

Light wave of incidence

Reflected light wave from the bottom

Reflected light wave from the top



$$4 \frac{\lambda}{4} = n \cdot t$$

Destructive interference

$$3 \frac{\lambda}{4} = n \cdot t$$

Constructive interference

$$2 \frac{\lambda}{4} = n \cdot t$$

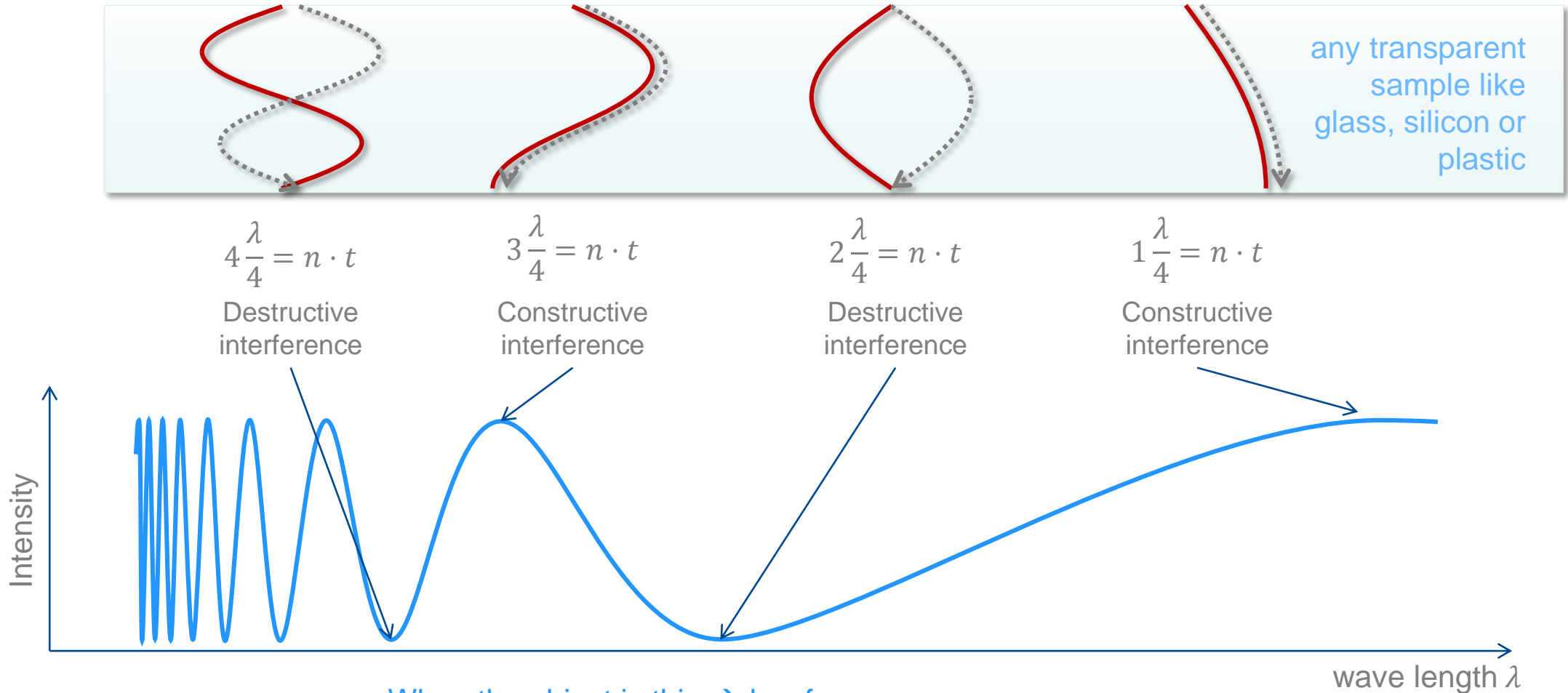
Destructive interference

$$1 \frac{\lambda}{4} = n \cdot t$$

Constructive interference

# TECHNOLOGY AND ADVANTAGES

## SPECTRAL-INTERFEROMETRIC SENSOR – HOW IS IT WORKING?

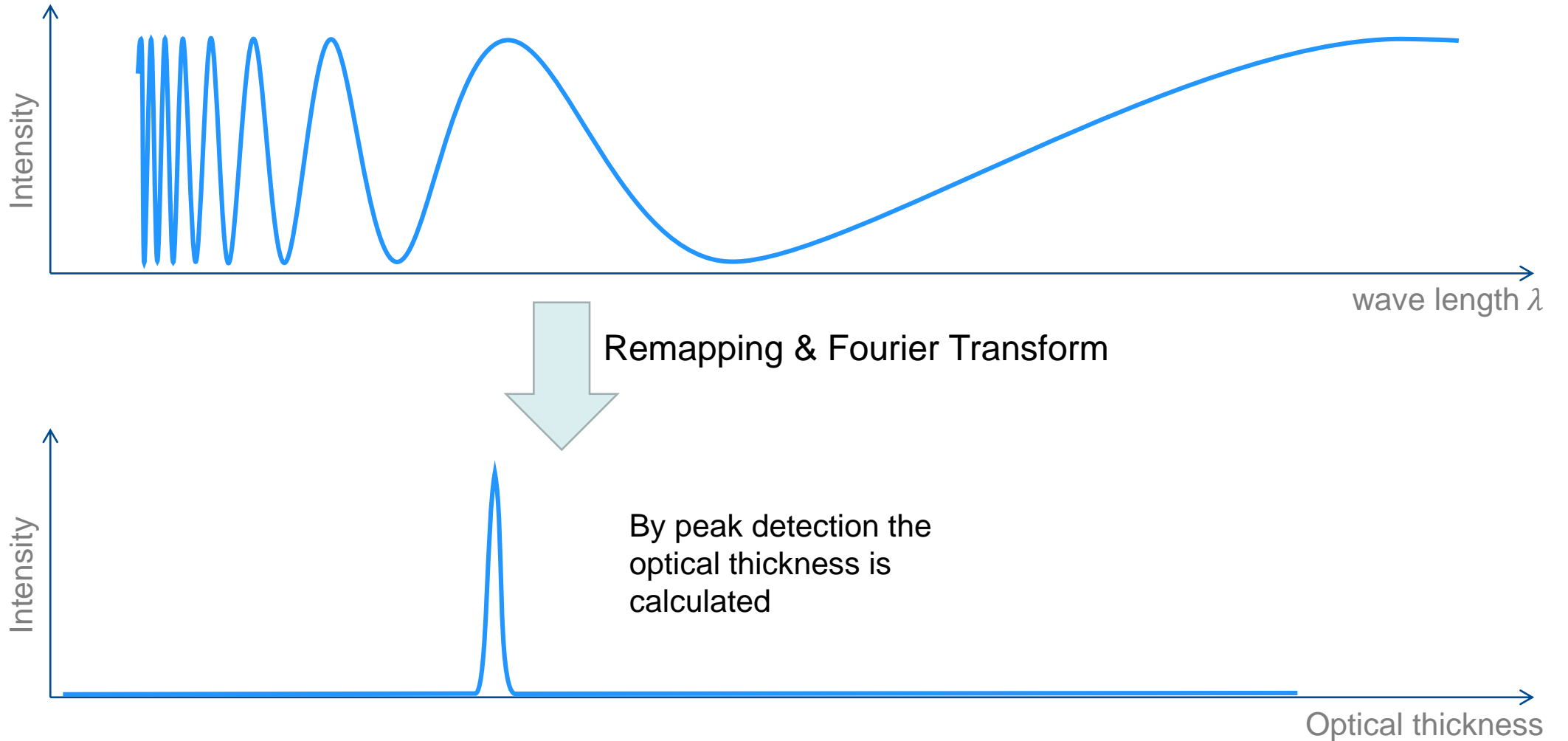


When the object is thin → low frequency

When the object is thick → high frequency

# TECHNOLOGY AND ADVANTAGES

## SPECTRAL-INTERFEROMETRIC SENSOR – HOW IS IT WORKING?





# TECHNOLOGIES AND ADVANTAGES

## SPECTRAL INTERFEROMETRY OFFERS MANY ADVANTAGES

- Thickness measurement is possible on many kinds of materials
  - Opaque (plastics, glues, bonding...)
  - Transparent (glass, clear plastics, polymers, Si, GaN, SiC...)
- Coaxial measurement avoids shadowing effects
- Multilayers thickness measurement
- Very high resolution (lateral resolution in micron range) and accuracy (to a few nanometers)
- Compact and passive probe, easy to integrate
- Very stable measurement, insensitive to vibrations

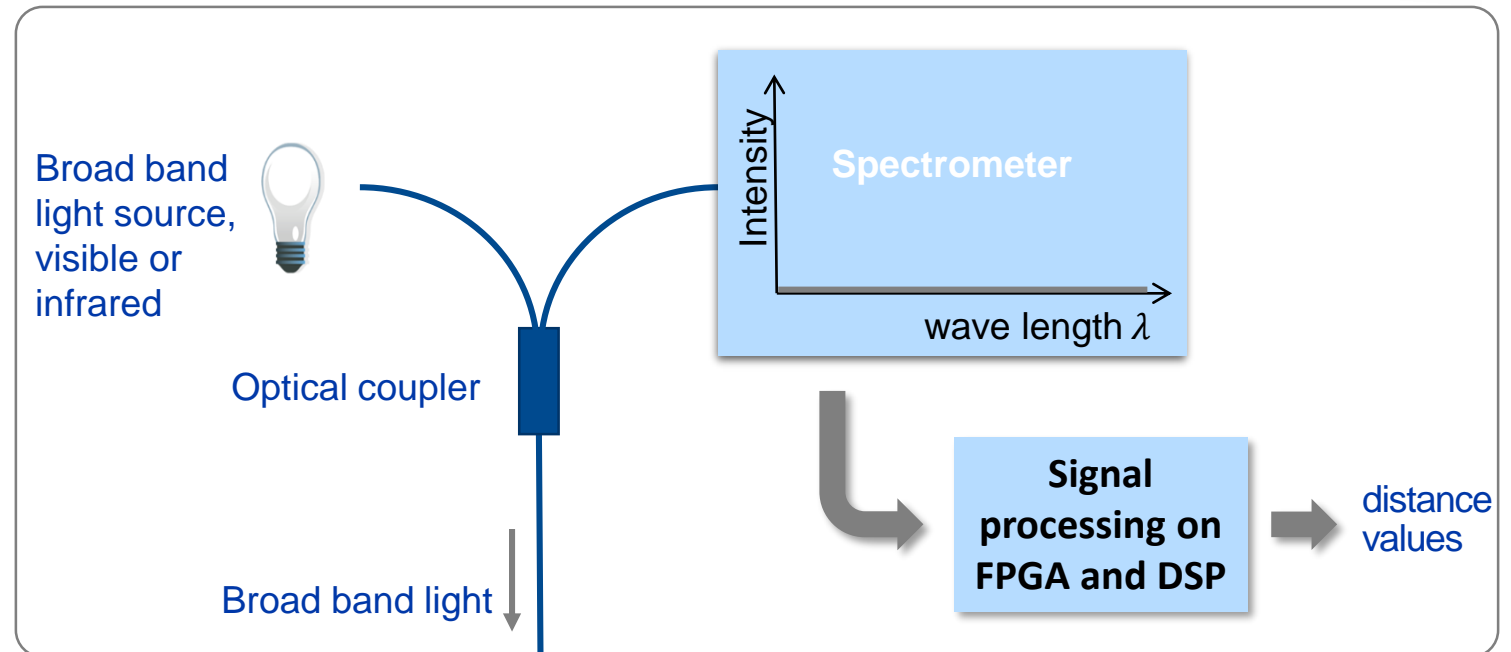
# INTERFEROMETRIC SENSORS

## CONTROLLER UNITS: CHRocODILE 2 IT SERIES

- Measuring speed up to 70 kHz
- Measuring range from  $\mu\text{m}$  to several mm
- Thickness measurement (single and multi layer)
- Synchronization I/O
- Ethernet or RS422
- Analogue outputs
- Up to 5 encoders inputs



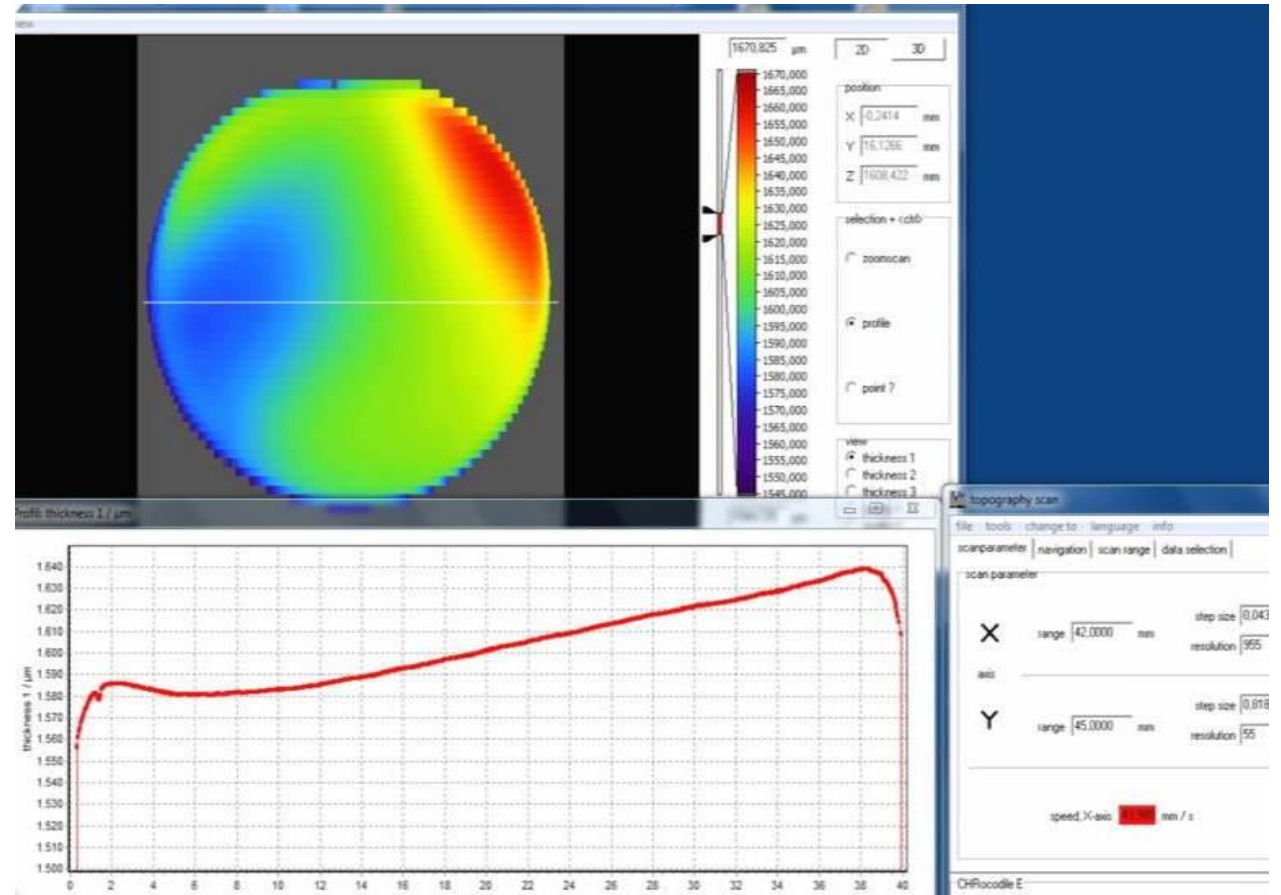
Schematic structure of the CHRocodile 2 IT



# APPLICATION EXAMPLES

## SILICON WAFER: TOTAL THICKNESS VARIATION

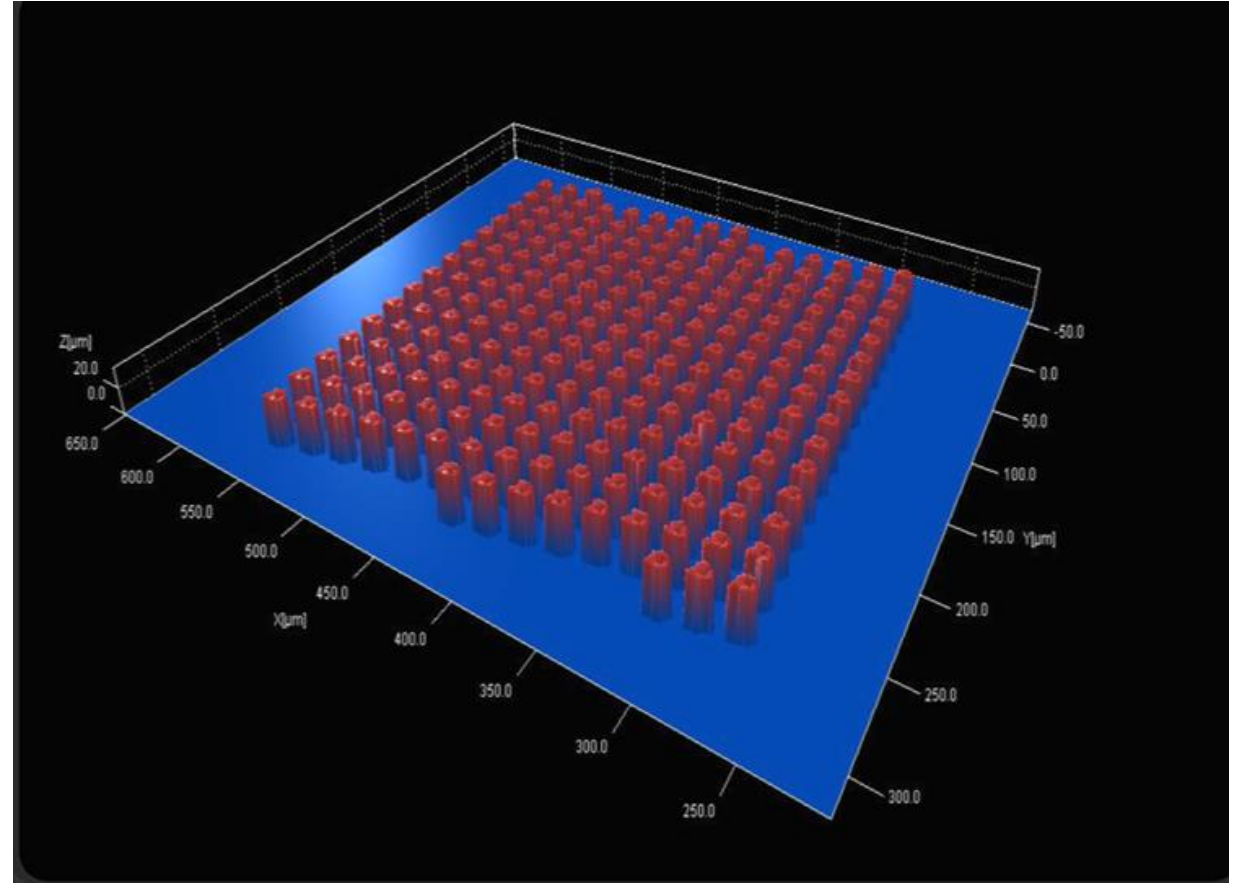
- Optical Sensor: CHRcodile IT
- Optical Probe: interferometric
- Scan area: 40 mm x 40 mm
- Z range: 1.6 mm
- X,Y resolution: 0.1 mm x 0.1 mm
- Measurements / second: 4,000



# APPLICATION EXAMPLES

## TSV WAFER: DEPTH OF VIAS

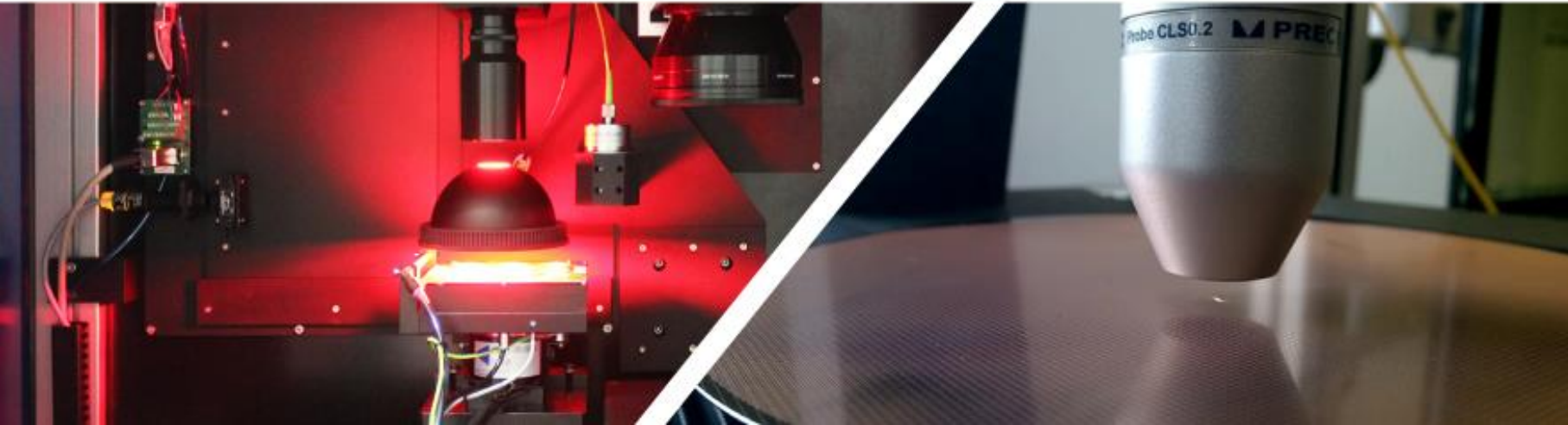
- Optical Sensor: CHRocodile LR
- Optical Probe: interferometric IR
- Scan area: 40 mm x 40 mm
- Z range: 30  $\mu\text{m}$
- X,Y resolution: 1  $\mu\text{m}$  x 1  $\mu\text{m}$
- Measurements / second: 4,000



# APPLICATION EXAMPLES

## FURTHER POSSIBLE APPLICATIONS

- Thickness measurement of ...
  - Bonded wafers, all layers at once
  - Sapphire wafers
  - TFT glass, inline during thinning process
  - Coatings such as resin
  
- Distance measurement for an autofocus in wafer laser dicing  
Remark: this requires an optical setup, supplying a reference beam



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